

UNITED STATES DISTRICT COURT  
FOR THE WESTERN DISTRICT OF NORTH CAROLINA  
ASHEVILLE DIVISION

STATE OF NORTH CAROLINA	)	
ex rel. Roy Cooper,	)	
Attorney General,	)	
	)	
Plaintiff,	)	No. 1:06-CV-20
	)	
vs.	)	VOLUME 3B
	)	(Pages 650-766)
TENNESSEE VALLEY AUTHORITY,	)	
	)	
	)	
Defendant.	)	
	)	

TRANSCRIPT OF TRIAL PROCEEDINGS  
BEFORE THE HONORABLE LACY H. THORNBURG  
UNITED STATES DISTRICT COURT JUDGE  
JULY 16th, 2008

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Cheryl A. Nuccio, RMR-CRR, Official Court Reporter

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1 WEDNESDAY AFTERNOON, JULY 16, 2008

2 THE COURT: Mr. Goodstein.

3 MR. GOODSTEIN: Thank you, Your Honor.

4 NEIL WHEELER

5 DIRECT EXAMINATION (Cont'd.)

6 BY MR. GOODSTEIN:

7 Q. Mr. Wheeler, where we left off was your description of  
8 the model performance confirmation that was done by VISTAS and  
9 also your evaluation of whether 2002 was an appropriate base  
10 year.

11 A. Yes.

12 Q. And we were turning your attention to Plaintiff's Exhibit  
13 133 for identification.

14 A. So the two things that we did, we looked at both the  
15 fourth highest 8-hour ozone concentrations from 1999 to 2005  
16 with the year 2002 when we modeled in the center of those  
17 years. We calculated from EPA's data the fourth highest  
18 8-hour ozone concentration which is a -- is a metric that is  
19 used with the standard for ozone. And we averaged those  
20 values over all sites in North Carolina and also averaged them  
21 over all of the regions 3 and 4, those are the EPA regions  
22 designations, which covered most of our modeling domain.

23 And so what we -- you can see here is that there's some  
24 variation from year to year. In 1999 the North Carolina  
25 concentrations averaged at 92, and in year 2002 they were 94,

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1 and in 2005 they were 80.

2 We look at this variation -- this is very typical of the  
3 meteorological variation over multiple years. There may be  
4 some changes in emissions over these years, but these are  
5 generally produced by year-to-year variations in meteorology.  
6 In picking a year for modeling, we like to have something that  
7 is kind of in the average values for the years surrounding it.  
8 Often -- we may want it a little bit higher than normal so  
9 that we have some conditions that need to be controlled.

10 But looking at this particular plot, we see that these  
11 are pretty typical years. The year-to-year variations are not  
12 very large.

13 On the other exhibit --

14 Q. This is --

15 A. -- which was 134.

16 Q. Yes.

17 A. Was the same sort of analysis for PM<sub>2.5</sub>.

18 Q. What did you confirm about using 2002 as the base year  
19 for your modeling?

20 A. This was a reasonable year. It was consistent with the  
21 selection criteria that VISTAS used for the model -- selected  
22 modeling year. And that there weren't significant deviations  
23 from the following years either.

24 Q. And what did you do to confirm that the VISTAS version of  
25 the CMAQ model that you set up on STI's computers, your

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1 computer system, was performing right?

2 A. We actually ran the base case simulations and reviewed  
3 the results. Compared them to the VISTAS results and  
4 confirmed that we were replicating their base case simulation  
5 for 2002.

6 Q. And what did that show?

7 A. What that showed was that there was adequate model  
8 performance to use the modeling tool for future year controls  
9 strategy simulations.

10 Q. So what did VISTAS confirm about the performance of the  
11 CMAQ model?

12 A. What did the...

13 Q. What did VISTAS confirm and then what did you confirm?

14 A. Well, what VISTAS confirmed that model performance was in  
15 that envelope I was talking about for all of the important  
16 species and that it was suitable for running future year  
17 scenarios and evaluating control scenarios.

18 Q. So it was sufficiently accurate and precise for the  
19 purposes of VISTAS and also for your purposes.

20 A. Yes.

21 Q. Can you describe for us the domain, the modeling domain  
22 that you looked at in your modeling that you did in this case.

23 A. May I approach the...

24 Q. Sure. And you can refer to Plaintiff's Exhibit 136.

25

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1           MR. GOODSTEIN: With the court's permission, if  
2 Mr. Wheeler can approach the exhibit.

3           THE COURT: You may.

4           (Witness stepped down from the witness stand.)

5           THE WITNESS: The modeling domain that VISTAS used,  
6 as I mentioned earlier, included more than just the VISTAS  
7 states. We placed this on -- over a map of the eastern United  
8 States, and the boundary around this is the VISTAS fine  
9 resolution domain. It was at 12 kilometer resolution. The  
10 boxes or the grid cells were 12 kilometers on the side  
11 horizontally. There's actually a much larger domain that's  
12 run for VISTAS as well as the other RPOs that covers the  
13 entire United States, so that each of the RPOs as they model  
14 their particular region can provide inputs to the other  
15 regions as well.

16           We've noted here that TVA coal-fired power plants  
17 are centered in the -- almost the very center of the domain,  
18 and that we put some annotation on here to show us where the  
19 Great Smoky Mountains National Park is, the Blue Ridge Parkway  
20 and the Appalachian Trail.

21           One of the things about this region, if we look at  
22 the meteorology over many years, and particularly in 2002,  
23 that the flows aloft over this section of the United States  
24 are generally from west to east. They are -- have some waves  
25 in them that vary from day to day.

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1           As we moved closer down to the surface, the winds  
2   become more complicated. They're affected by areas of high  
3   and low pressure. One of the features of southeastern  
4   meteorology is that during the summer months when the ozone  
5   and particulate matter reaches its highest concentrations,  
6   there's a high pressure system that resides off the coast of  
7   the southeast and the flow around that is clockwise like this  
8   (indicating). And that high from day to day can move up and  
9   down, sideways a little bit. And as it does that, the flows  
10  over this region at the surface can go from sort of  
11  northwesterly to westerly to southeasterly depending on the  
12  position of that high pressure system.

13           So when we look at the transport in this region,  
14  there is a tendency for the transport of pollutants to be from  
15  west to east.

16  Q.   Thank you, Mr. Wheeler.

17           (Witness resumed the witness stand.)

18  Q.   You also, Mr. Wheeler, provided a close-up in your report  
19  of the CMAQ model domain in North Carolina and Tennessee, and  
20  I believe it's marked as Plaintiff's Exhibit 137.

21  A.   Yes, we did provide an image that shows a close-up of the  
22  region. We zoomed in to the center and focused along the  
23  Tennessee and North Carolina border. And we've annotated this  
24  to help us as we did our analysis with key features, some  
25  locations of interest, such as Grandfather Mountain, the

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1 Biltmore Estate, we have the Class I areas we talked about  
2 yesterday that are national parks and wilderness areas that  
3 are protected for prevention of significant deterioration.  
4 Here we have the Great Smoky Mountains National Park, Chimney  
5 Rock State Park, Joyce Kilmer Slickrock, which is a Class I  
6 area, and there's several others on this plot.

7 But this would allow us to be focusing on the impacts  
8 from power plants along the North Carolina/Tennessee border.  
9 And there are four power plants that are very close to the  
10 border: John Sevier, Bull Run, Kingston, and there's one  
11 further down slightly, if we could move the plot down a little  
12 bit, and to -- yes, that's great -- and Widows Creek. And  
13 these are the closest to North Carolina and are -- have a  
14 large influence on the impacts in North Carolina due to the  
15 wind flows in this region.

16 Q. All right. I'll refer your attention, Mr. Wheeler, to  
17 Plaintiff's Exhibits 138, 98 -- these should be in your  
18 book -- 99, 100.

19 A. I see it.

20 Q. Could you identify what those summary tables in your book  
21 represent.

22 A. These represent the emissions from North Carolina -- CP&L  
23 and -- I mean, Duke -- Duke and Progress power plants in North  
24 Carolina. These show the 2002 emissions and the 2003  
25 emissions that are projected based on the 2005 report on Clean

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1 Smokestacks. These are the emissions that we modeled in North  
2 Carolina for North Carolina in our modeling efforts.

3 Q. And Plaintiff's Exhibit 98.

4 A. The next exhibit is the NOx emissions from TVA coal-fired  
5 power plants estimated for our 2013 base case. That's our  
6 on-the-books simulation. And these were provided to us by  
7 Dr. Staudt. It continues for several pages.

8 Q. Okay. And Plaintiff's Exhibit 99.

9 A. The next exhibit is the 2013, it's a -- this is 99?

10 Q. Yes.

11 A. These are the SO<sub>2</sub> emissions from the TVA coal-fired power  
12 plants for our 2013 base case simulation. These also were  
13 provided by Dr. Staudt.

14 Q. And Plaintiff's Exhibit 100.

15 A. 100 are the NOx emissions for the TVA coal-fired plants  
16 with the additional controls sought by North Carolina.

17 Q. And Plaintiff's Exhibit 101.

18 A. And the final one is the SO<sub>2</sub> emissions with the  
19 additional controls sought by North Carolina. This, too, was  
20 provided to us by Dr. Staudt. All of these last four exhibits  
21 were used to prepare the 2013 base case simulation, emissions  
22 for that simulation and the 2013 control case.

23 Q. All right.

24 MR. GOODSTEIN: At this time, Your Honor, I want to  
25 offer some exhibits into evidence. Mr. Wheeler's CV, Exhibit

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1 427, and then the exhibits we have covered so far in his  
2 examination, 127, 128, 129, 130, 131, 132, 133, 134, 136, 137  
3 and 138.

4 THE COURT: All right. Let those be admitted.

5 (Plaintiff's Exhibits Numbers 127, 128, 129, 130,  
6 131, 132, 133, 134, 136, 137, 138 and 427 were received into  
7 evidence.)

8 MR. FINE: Mr. Goodstein, did you cover the ones you  
9 just covered with him?

10 MR. GOODSTEIN: The ones that we covered with  
11 Dr. Staudt's emissions estimates have previously been  
12 admitted.

13 MR. FINE: Thank you, Mr. Goodstein. I appreciate  
14 that.

15 MR. GOODSTEIN: Thank you.

16 Q. All right. Mr. Wheeler, you loaded these emissions up  
17 into the CMAQ model and you produced some results.

18 A. Well, actually, we ran three simulations with CMAQ with  
19 the 2000 -- with the 2013 emissions.

20 The first simulation that we performed was with inert  
21 tracers. Inert tracers are chemical species that don't react  
22 with any other compounds in the atmosphere.

23 MR. FINE: Your Honor, I need to interpose an  
24 objection before we get into any of this inert tracer  
25 testimony.

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1           As the witness has just said, they don't react with  
2 anything. They don't really show anything. And the exhibits  
3 that are drawn from this inert tracer, in fact, measure things  
4 in parts per trillion. Inert tracers, if they show anything,  
5 tend to show which way the wind blows. They have no physical  
6 characteristics. They're not reasonable simulacrums or  
7 facsimiles for any known pollutants. Have, as I say, no  
8 physical characteristics at all. We don't know whether  
9 negatively or positively bouyant. We don't know for what  
10 species of pollutant they would be held to be representative  
11 of. So that the whole exercise ultimately shows nothing  
12 that's of any value.

13           On those grounds we'd ask that this line of  
14 questioning and any exhibits associated with it be excluded as  
15 irrelevant.

16           MR. GOODSTEIN: Your Honor, we respectfully request  
17 that the expert who's qualified on the stand to testify about  
18 these matters be allowed to testify about them. At this point  
19 we're just getting out in the record the simulations that  
20 Mr. Wheeler ran. The inert tracer, as Mr. Wheeler will  
21 testify to, is an initial screening tool that's helpful for  
22 modelers and air quality analysts to set up the model and  
23 confirm various parameters about it and also gives them an  
24 indication of the meteorology in the area. And in fact,  
25 Dr. Tesche, who will later in this trial testify for Tennessee

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1 Valley Authority, says right in his report that inert tracers  
2 are an appropriate screening tool.

3 So we will lay the foundation with Mr. Wheeler and  
4 then we can confirm it later on in the trial with Dr. Tesche  
5 because that's right out of his report.

6 MR. FINE: Just want to make it clear, Your Honor,  
7 that these ultimately show nothing and that -- if there is --  
8 if they're a useful screening tool, I don't know why we're  
9 burdening the record with them since there's no controversy  
10 about the adequacy of the CMAQ model for measuring -- for  
11 modeling atmospheric impacts from emissions. I think that  
12 frankly, Your Honor, in all candor, this is a waste of the  
13 court's time.

14 MR. GOODSTEIN: And we will show, Your Honor, that  
15 this is part of the scientific evidence that Mr. Wheeler and  
16 his colleague Mr. Chinkin are relying on in this case in part.  
17 So it's not a waste of anybody's time. We're going to move  
18 through it very quickly, but it's part of the analysis that  
19 they did and in their field this is an important initial step  
20 in the modeling analysis.

21 So I would submit that we ought to just let the  
22 witness testify about the scientific evidence that he's  
23 presenting as opposed to hearing from counsel about what it  
24 shows.

25 THE COURT: All right. I'll let them in and make a

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1 final decision --

2 MR. GOODSTEIN: Thank you, Your Honor.

3 THE COURT: -- as to whether to consider them or of  
4 what value they may be. All right.

5 MR. GOODSTEIN: Thank you, Your Honor.

6 Q. All right. Mr. Wheeler, you were telling us about the  
7 modeling that you did.

8 A. Yes. Inert tracers are useful tools for diagnostic  
9 purposes in the model to determine whether there are  
10 inconsistencies in the meteorological fields that cause  
11 unusual transport. They're also used to determine potential  
12 for transport. Not necessarily that there's a specific  
13 impact, but that there is a potential.

14 And the way we applied them here, we simulated a separate  
15 tracer for each of the power plants, TVA's coal-fired power  
16 plants and scaled the emissions of this inert tracer to their  
17 SO<sub>2</sub> emissions. That way we could look at the various range of  
18 potential impact and compare them between sites -- between  
19 sources. And this gives us an idea of which ones might have  
20 the greatest contribution, which ones have the most likelihood  
21 of transporting to other parts of the modeling domain. So  
22 these are a useful tool for that purpose.

23 We in no way imply that these are impacts specifically,  
24 but this is a first step in a lot of modeling studies because  
25 we don't want to go into full chemistry modeling when there's

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1 no potential for impact in a particular region. So it's a  
2 first step in the analysis.

3 Q. And what did your inert tracer analysis show,  
4 Mr. Wheeler? And feel free to --

5 A. I have a series of exhibits. We might show one of those  
6 and then quickly move through those.

7 Q. All right. And what was your -- what was the -- what was  
8 the overall conclusion that was reached?

9 A. The overall conclusions were there was a potential of  
10 impact from each of the sources that we modeled from TVA power  
11 plants and that the -- not surprisingly, that the impacts or  
12 potential for the impact were closer -- were larger nearer the  
13 plants and less at further distances downwind. But in all  
14 cases, there was potential for impact into North Carolina and  
15 many other states throughout the domain.

16 Q. All right. Can you -- referring to Plaintiff's Exhibit  
17 139 in your book, please, show us what the results of these  
18 initial inert tracer analyses provide.

19 A. Yes. We'll show quite a number of these sort of plots,  
20 color contour plots. And I might just orient everyone that in  
21 each of these we have an axis indicating the color bands and  
22 what the concentrations are.

23 In this case, as Mr. Fine pointed out, these are in parts  
24 per trillion. They're not reactive and shouldn't be  
25 considered as a measure of impact, but they do show a measure

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1 of potential for impact.

2 The -- in this one we see that the highest potential is  
3 near the power plants, in this case it's for John Sevier. And  
4 there tends to be a greater extent of potential extending to  
5 the east from the power plant than to the west.

6 Q. All right. Why don't you run through the series real  
7 quickly.

8 A. Sure. The second one was at Bull Run. Again, no  
9 surprises here. It looks very similar. We see the extent --  
10 potential extending further to the east than west.

11 If we go to Kingston, we see similar -- we see a much  
12 broader pattern here. This would be due to the higher  
13 concen -- higher emissions rates at Kingston in our 2013 case.

14 And the next one is Widows Creek, a smaller footprint  
15 from that one, but again, consistent in terms of impacts  
16 extending further to the east.

17 I neglected to mention that these are annual averages so  
18 it includes periods where there were storms coming through  
19 during the course of the year and so there are some impacts  
20 when flow was from east to west and that's why we see a  
21 potential to the west as well.

22 The next one was at Gallatin. Again, it's located a  
23 little further to the north and further away from North  
24 Carolina. And again, we see a very similar sort of pattern.

25 And the next one was Paradise. Paradise with impacts

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1 further to the north and much higher potential impacts shown  
2 in the purple area there.

3 And the next one is Cumberland. Cumberland shows a  
4 similar pattern.

5 And if we go to the next one, which is Colbert, again, a  
6 very similar pattern. Slightly higher potential around the  
7 plant for impacts.

8 And the next one is Johnsonville. Here we see a much  
9 broader pattern of potential impact extending -- some of the  
10 highest levels extending to, looks like one, two, three, four,  
11 five, six other states.

12 And finally -- well, there's two more. Shawnee. Again,  
13 a very similar pattern.

14 And then finally Allen.

15 As we see from these, that while -- what we concluded was  
16 that obviously the potential for impact is highest nearest the  
17 emissions source, but there is a potential for impact to North  
18 Carolina in all of these.

19 So based on these analyses, we felt comfortable going  
20 ahead with full chemistry simulations to assess impacts in  
21 North Carolina through the region.

22 MR. GOODSTEIN: We offer Plaintiff's Exhibit 139  
23 into evidence, Your Honor.

24 MR. FINE: We'll object to that, Your Honor.

25 THE COURT: All right. Let it be admitted.

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1           (Plaintiff's Exhibit Number 139 was received into  
2 evidence.)

3           MR. GOODSTEIN: Thank you, Your Honor.

4 Q. I want to refer your attention, Mr. Wheeler, to  
5 Plaintiff's Exhibit 140 for identification.

6 A. Okay.

7 Q. Mr. Wheeler, as part of the results from your CMAQ  
8 modeling analysis, were you able to do a visualization of  
9 TVA's SO<sub>2</sub> emissions?

10 A. Well, one of the things we did in developing the base  
11 case simulations was to do what we call a visualization, a  
12 three-dimensional visualization or a movie of air quality in  
13 the region. This is -- we used a tool called VIS-5D. It's  
14 been around for about 20 years in the meteorological community  
15 and used over the last decade for air quality simulations.  
16 And it's a diagnostic tool to help us understand the  
17 three-dimensional nature of the atmosphere.

18       Usually when we're looking at these plots, like we were  
19 looking at the inert tracer, they're a layer at the surface  
20 and you don't get a sense of what's really going on in the  
21 atmosphere; that, you know, thousands of feet in the area that  
22 chemistry is going on, transport is going on. And it's not  
23 always apparent by looking at the ground level concentrations  
24 how they arrive at that particular location.

25       So what we did is we prepared a visualization of a

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1 four-day period during our 2013 base case simulation and  
2 visualized the SO<sub>2</sub> concentrations in the modeling domain. So  
3 this is actually results out of the CMAQ model. And we also  
4 visualized the sulfate aerosol that was produced in the  
5 atmosphere.

6 And if you'd like, I can take and describe this  
7 particular at the board.

8 Q. Yes.

9 MR. FINE: Your Honor, before we get too much  
10 farther into this, I'm going to interpose an objection. If I  
11 understand the term isosurface, that means that this does not  
12 show any particular concentrations so that all we have is an  
13 amorphous brown cloud. We don't know its altitude. We don't  
14 know its concentration.

15 We also note that contrary to what Mr. Wheeler says,  
16 this appears to be showing sources other than TVA power plants  
17 unless I'm misunderstanding the yellow plumes I see coming out  
18 of Mississippi and southern Alabama, Georgia, South Carolina  
19 and some other sites before they get swept up into our  
20 amorphous brown cloud.

21 Again, Your Honor, I don't think this shows anything  
22 of value other than to try and mislead the court as to the  
23 potential impacts from TVA's emissions.

24 MR. GOODSTEIN: Your Honor, that's an appropriate  
25 subject for cross examination, I think. Counsel will have a

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1 chance with this witness once we've passed him --

2 THE COURT: Yes.

3 MR. GOODSTEIN: -- but I think he should be --

4 THE COURT: You'll have full opportunity to cross  
5 examine him.

6 MR. GOODSTEIN: Thank you, Your Honor.

7 MR. FINE: Thank you, Your Honor.

8 THE COURT: The objection is overruled.  
9 We're dealing with 140?

10 MR. GOODSTEIN: Your Honor, if we can have  
11 Mr. Wheeler approach the exhibit so he can explain what it  
12 shows.

13 THE COURT: All right, sir.

14 (Witness stepped down from the witness stand.)

15 THE WITNESS: This simulation included more than  
16 TVA's facilities. This is all in our 2013 base case, and I  
17 did not make that statement.

18 But what we see here and the reason we do these sort  
19 of visualizations is to help explain how gases convert into  
20 particles in the atmosphere and are transported over long  
21 distances.

22 What we've done here is we've indicated SO<sub>2</sub>  
23 concentrations in the atmosphere -- and this is SO<sub>2</sub>  
24 concentrations in the model's atmosphere -- in yellow and  
25 created what we call isosurfaces. They were selected at

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1 concentration levels to depict common scales of plumes in the  
2 region.

3 And what we see is we see a number of SO<sub>2</sub> emissions  
4 various places. Correct, from areas throughout the region.  
5 We do see specifically here at Colbert and Johnsonville the  
6 plumes from those.

7 And I think the key issue here is we see that the  
8 sulfate forms downwind in the atmosphere. And we've prepared  
9 some movies of these from different angles. That's the way  
10 the tool is frequently used interactively saying I want to  
11 look at it from this direction, from this elevation. And we  
12 provided some movies that show the simulation over a four-day  
13 period to get an understanding of how transport and chemical  
14 conversion occurs in the atmosphere.

15 MR. FINE: Your Honor, I know that you've already  
16 ruled on the admissibility of this exhibit, but I believe  
17 based on Mr. Wheeler's testimony, the legend on this document  
18 is incorrect. It is not just visualizing TVA's SO<sub>2</sub> emissions,  
19 but visualizing SO<sub>2</sub> emissions from a large range of emitting  
20 sources, power plants, I'm assuming, for the most part,  
21 throughout a large region.

22 MR. GOODSTEIN: Which includes TVA's plants, Your  
23 Honor.

24 THE COURT: I'll note your statement, counsel.

25 MR. FINE: Thank you.

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1 MR. GOODSTEIN: Thank you, Your Honor.

2 (Witness resumed the witness stand.)

3 MR. GOODSTEIN: Your Honor, if I may approach the  
4 witness. I have a copy of the DVD which has this simulation  
5 on it that I'd like Mr. Wheeler to identify and then we can  
6 run it for the court --

7 THE COURT: All right.

8 MR. GOODSTEIN: -- with your permission.

9 THE WITNESS: Yes, this is one of the CDs I  
10 prepared.

11 MR. FINE: And before we have Wednesday afternoon at  
12 the movies, Your Honor, I would interpose an objection. I  
13 understand Your Honor's prior rulings on this subject, but for  
14 the record we would object to the playing of this movie.

15 THE COURT: All right, sir.

16 MR. GOODSTEIN: Thank you, Your Honor.

17 THE COURT: Yes. You may proceed.

18 BY MR. GOODSTEIN:

19 Q. Mr. Wheeler -- maybe we can put it up on the monitor and  
20 you can explain what it shows, Mr. Wheeler, because I  
21 understand it's a loop so we're not going to be able to stop  
22 it. So maybe you can tell us what it shows and then we'll run  
23 the loop.

24 A. So as I mentioned, it's a four-day period. And one of  
25 the things that we see here, this is a top view looking down

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1 over the entire modeling domain.

2 Q. I'm sorry. Do you want to tell us what it's going to  
3 show. Or you can narrate while it goes.

4 A. I can narrate.

5 Q. All right.

6 A. But what it's going to show is the general regional  
7 transport in the region in this period of the presence of the  
8 high pressure system off the coast of the southeast and that  
9 general clockwise rotation. Some days it's more westerly,  
10 some days it's a little bit more from the southwest. We also  
11 see some periods where it flows across the Appalachians and  
12 comes back down on the back side of them down into North  
13 Carolina.

14 Q. I'm sorry, I just wanted to make you -- give you a little  
15 time to explain it. So now let's run it.

16 A. Okay. As I mentioned earlier, the SO -- the sulfate or  
17 SO<sub>4</sub> isosurfaces are in brown and the SO<sub>2</sub> concentrations are in  
18 yellow. And as I mentioned, we see that circulation like that  
19 around the southeastern region. We see transport across the  
20 Appalachians, some penetration through the gaps in the area.  
21 And as I said, it runs for four days.

22 We'll look at it again on a slightly angled view so you  
23 can get a sense of the vertical extent of the SO<sub>2</sub> plumes and  
24 that the reactions to the formation to sulfate occur at higher  
25 elevations above the surface.

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1 Normally we'd be looking at this interactively and  
2 rotating it and trying to investigate where particular sources  
3 are.

4 This is a close-up view focusing in over Tennessee and  
5 North Carolina. We can see the vertical extent of the plumes  
6 in this somewhat, but we clearly see the conversion of SO<sub>2</sub> to  
7 sulfate, that the concentrations of SO<sub>2</sub> decrease further  
8 downwind from the sources and that the sulfate forms down --  
9 further downwind.

10 And I believe that's it.

11 Q. With regard to the transport of pollutants that are  
12 emitted from TVA power plants, what were you able to conclude  
13 based on this visualization?

14 A. Well, I think in several cases we can see specific plumes  
15 that do -- are transported from TVA power plants into North  
16 Carolina and other parts of the region. Sometimes those  
17 are -- couldn't necessarily in this simulation identify each  
18 TVA facility because in many cases the plumes, SO<sub>2</sub> plumes were  
19 obscured by the sulfate plumes.

20 Q. And were you able to identify any of the TVA plant  
21 plumes?

22 A. Yeah. As I mentioned, it was very clear, the Colbert and  
23 Johnsonville plumes, and I think on other periods we saw  
24 several of those.

25 MR. GOODSTEIN: Your Honor, we offer Plaintiff's

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1 Exhibit 141 into evidence.

2 MR. FINE: Objection, Your Honor.

3 THE COURT: Overruled.

4 (Plaintiff's Exhibit Number 141 was received into  
5 evidence.)

6 Q. Mr. Wheeler, can you tell us which scenarios you ran for  
7 2013 and then show us your results.

8 A. Yes. As I mentioned, we did the inert tracer  
9 simulations. But the focus of our analysis was on the 2013  
10 base case, the 2013 control case with the reductions sought by  
11 North Carolina, and then we did differences between those  
12 simulations.

13 Obviously, there's a lot of plots that can be generated  
14 from these simulations. We have 19 layers in the model,  
15 nearly a hundred species that are being modeled, and we can  
16 spend a lifetime looking at these. We spent many days looking  
17 at them to understand what the model is predicting.

18 To prepare this data to provide to the health effects  
19 experts and ecosystem experts, we provided them all of that  
20 data for their analysis. But we needed to come up with some  
21 summaries of those so that they could assess whether what  
22 they're seeing in their analysis is consistent with our data.  
23 They actually replicated some of our analyses to verify that.

24 So we looked at a couple of different types of summary  
25 plots for these.

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1       The first set were 24-hour average concentrations of  
2   particulate matter, PM<sub>2.5</sub>. And we looked at some sample  
3   dates, four days, one during each season, looking at the --  
4   both the concentrations in the base case and the differences  
5   or the decreases in concentrations under the control scenario.  
6   We did that for four -- for four different days of the  
7   annual -- for the 24-hour averages.

8       We also looked at the maximum 24-hour change over the  
9   course of the year in each grid cell within the modeling  
10   domain.

11       And then finally, we looked at the annual average PM<sub>2.5</sub>  
12   concentrations predicted by the model and the difference that  
13   would occur, the improvements that would occur as a result of  
14   the controls sought by North Carolina.

15       So those are displayed -- we -- in our report as summary  
16   graphics.

17       And we also did a similar analysis for ozone as well. We  
18   looked at on several occasions the peak 8-hour ozone on those  
19   days and the differences as a result of the additional  
20   controls.

21       We also looked at the maximum improvement over the course  
22   of a year in each grid cell as a result of the additional  
23   controls.

24   Q.   All right. Mr. Wheeler, thank you.

25       And referring your attention to Plaintiff's Exhibit 142.

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1 Can you walk us through the results for the 24-hour PM<sub>2.5</sub>  
2 concentrations. And I believe you have a few individual days.  
3 A. Yes, this was one of the days. As I mentioned, we try to  
4 pick a day from each season to give kind of a summary over the  
5 course of the year.

6 Again, just to orient everyone on these scales, the scale  
7 on the left indicates the concentrations for each of these  
8 color bands in micrograms per cubic meter. And then on the  
9 right we have the differences between the base and the control  
10 case. And these are presented in this display of percent  
11 improvement or percent decrease in concentrations.

12 And what we see on this particular one is that for most  
13 areas there's generally a 1 to 3 percent improvement in  
14 concentration on a daily basis. There are a few places where  
15 the differences increase. I think the largest improvement was  
16 12 percent improvement over the region.

17 Q. All right. If you could move us through the rest of the  
18 individual day plots that you have for the 24-hour PM<sub>2.5</sub>.

19 A. Yes.

20 Q. That will be 143 through 146 for identification.

21 A. Yes. This one is for April 18th, 2013 base case. One is  
22 the control scenario. And what we see here is a little bit  
23 more distinct, what I call plumes of improvement downwind of  
24 TVA sources. This is more typical of late spring and  
25 summertime conditions.

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1       The next plot was for July 27th, and later in the year  
2       the temperature and other conditions for formation of PM<sub>2.5</sub> is  
3       enhanced and we actually see a much larger change as a result  
4       of the controls. In this case it looks to be over, at the  
5       maximum point, more than 30 percent improvement.

6       Q.   And just so we're clear, Mr. Wheeler, that the change  
7       figure on the right represents the impacts of TVA facilities  
8       and the changes in concentrations of these pollutants in the  
9       domain resulting from the additional controls being applied.

10      A.   To be clear, these are not the total impacts from TVA  
11      facilities. This is a scenario where we're looking at the  
12      difference between the base case and the initial controls  
13      sought. The total impact in what we call a zero-out emissions  
14      sensitivity would be larger than this.

15      Q.   So you're showing the actual concentrations on the  
16      left-hand figure.

17      A.   The predicted concentration of the absolute  
18      concentration.

19      Q.   And on the right you're showing the change --

20      A.   In percent changes.

21      Q.   -- in TVA's emissions with and without the additional  
22      controls sought by North Carolina.

23      A.   The right indicates the percent change in concentrations  
24      as a result of the additional controls.

25      Q.   And can you see on the right, for example, in Plaintiff's

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1 Exhibit 144, can you see some of the individual plume effects  
2 from TVA power plants?

3 A. Yes. This is actually very clear in here where the  
4 improvements, as I mentioned earlier, call them plumes of  
5 benefit. You can see the benefits emanating from the source  
6 areas and we can pick out a whole number of those.

7 Q. And these plumes emanating from Tennessee or the areas in  
8 Alabama and Kentucky around Tennessee, those are associated  
9 with the TVA power plants.

10 A. Yes.

11 Q. And what about Plaintiff's Exhibit 145 for  
12 identification?

13 A. Again, this is a similar sort of analysis for another  
14 day, October 2nd. And likewise, the impacts -- the area of  
15 largest impacts is not as great, but on this particular day  
16 there were significant improvements with the additional  
17 controls in North Carolina. We can see that right in this  
18 area here (indicating). And those are on the order of  
19 24 percent improvement.

20 Q. So the darkest blue area on this day in North Carolina  
21 shows the maximum improvement area resulting from the  
22 additional controls being applied to TVA's facilities.

23 A. Yes, that's correct.

24 Q. All right. Mr. Wheeler, you also presented a figure in  
25 Plaintiff's Exhibit 146 which also showed 24-hour average

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1 PM<sub>2.5</sub> concentrations. Can you explain to us what this figure  
2 shows.

3 A. Yes. In this analysis we looked over the entire year and  
4 looked at the maximum improvement in a 24-hour average of  
5 PM<sub>2.5</sub> at any grid cell in the modeling domain, and then that  
6 maximum improvement is plotted on this. And this whole area  
7 indicated in purple indicates that more than a 25 percent  
8 improvement in those grid cells at least one day during the  
9 simulation year.

10 Q. And referring you to Plaintiff's Exhibit 147. Can you  
11 explain to us what those results show.

12 A. Yes. Similar plots on a daily basis, the 24-hour  
13 averages. We also did -- looked at the improvement over the  
14 entire year.

15 So on the left is the model's prediction in 2013 of the  
16 absolute PM<sub>2.5</sub> concentrations across the region.

17 And on the right-hand side shows the percent improvement  
18 resulting from the additional controls on TVA's facilities.

19 And this is the statistic -- one of the statistics that  
20 we provided to the health effects experts for assessing these  
21 impacts.

22 And what we see here is that there are two areas in  
23 Tennessee that have some very -- that have more than 4 percent  
24 improvement on an annual average, which is really quite large  
25 considering it's averaged over an entire year.

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1 And the third area is in western North Carolina.

2 So these are not just particular days during the year  
3 which it impacts; this is on an annual basis. These are the  
4 things -- these are the annual standard that have the greatest  
5 impacts.

6 Q. And how would you describe the impacts and the  
7 improvement as far as aerial extent associated with the  
8 additional controls sought by North Carolina?

9 A. I think these are substantial impacts on air quality, in  
10 particularly Tennessee and North Carolina, but throughout the  
11 region.

12 Q. Referring your attention to Plaintiff's Exhibit 148. Can  
13 you identify that figure and explain what it shows.

14 A. This is a plot that we provided in our supplemental  
15 report.

16 Q. Uh-huh.

17 A. Showing the differences resulting from the additional  
18 controls based on an absolute basis in micrograms per cubic  
19 meter. The other ones were in percent.

20 And these show that there is greater than four-tenths of  
21 a microgram on an annual average improvement in both North  
22 Carolina and Tennessee, and that there are substantial impacts  
23 that extend as far east as the coast.

24 Q. All right. And Plaintiff's Exhibit 148 has a second page  
25 to it. And can you tell us what that shows.

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1 A. This is a close-up of the same data that you saw in the  
2 previous figure focusing in on Tennessee and western North  
3 Carolina. On this figure we've showed the power plants.  
4 We've showed the PM<sub>2.5</sub> nonattainment areas outlined in black,  
5 and the decrease in concentrations of PM<sub>2.5</sub> on an annual basis  
6 resulting from the additional controls.

7 Q. Mr. Wheeler, what are the counties that are circled in  
8 black?

9 A. The dark outlined counties are the nonattainment areas,  
10 or at least they would be at the time this was plotted.

11 Q. And what does that mean?

12 A. That means they're in violation of the National Ambient  
13 Air Quality Standards and that they are required to develop  
14 control programs to attain the standard.

15 Q. And when you see the blue improvement areas demonstrating  
16 the changes in concentration resulting from the additional  
17 pollution controls from TVA's plants and that darkened area  
18 extends into some nonattainment counties, what do you conclude  
19 from that?

20 A. Well, that tells me that that may be an effective control  
21 for reaching attainment as well in those areas.

22 Q. What does --

23 A. With the controls sought by North Carolina.

24 Q. What does that mean as far as TVA's contribution to the  
25 nonattainment status of those counties?

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1 A. That would tell me that there is some contributions to  
2 nonattainment in those areas.

3 Q. And that includes some counties in North Carolina.

4 A. Yes. We tend to focus on the darkest concentrations on  
5 these maps, but there is some impact in every area, every  
6 nonattainment area on this particular figure, whether it's in  
7 North Carolina, Tennessee, Kentucky, et cetera.

8 Q. When you say nonattainment county, can you tell us what  
9 significance that has on the Clean Air Act.

10 A. It requires them to adopt control programs to meet the  
11 standards or alternatively be subject to various sanctions,  
12 enforcement actions.

13 Q. So what does this tell you about TVA's contribution to  
14 the exceedance of National Ambient Air Quality Standards in  
15 those counties?

16 A. Yes.

17 Q. And there are nonattainment counties also in Tennessee  
18 that are being impacted by TVA's excess emissions?

19 A. Yes, there are.

20 MR. FINE: Your Honor, I'll object to the  
21 argumentative nature of that question.

22 MR. GOODSTEIN: Your Honor, we have to call it  
23 something and we could say -- we have to call -- the delta  
24 that we're looking at is the difference between emissions  
25 from -- with -- from TVA plants with the controls sought by

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1 North Carolina. So we have to refer to that delta in some way  
2 and I don't see any other way to refer to it other than excess  
3 emissions or excessive emissions.

4 MR. FINE: Your Honor --

5 MR. GOODSTEIN: That's been established in the  
6 evidence.

7 MR. FINE: If you look at the scale on these things,  
8 we're talking about amounts -- the greatest amount that seems  
9 to be shown is .4 micrograms per cubic meter. The idea of  
10 calling .4 micrograms per cubic meter -- the NAAQS -- the  
11 annual National Ambient Air Quality Standard for PM<sub>2.5</sub> is 15  
12 micrograms per cubic meter. Talking about 0.4 micrograms as  
13 excessive strikes me as argumentative.

14 MR. GOODSTEIN: Your Honor, we've had testimony --

15 THE COURT: Yes, I'll overrule the objection.

16 MR. GOODSTEIN: Thank you, Your Honor.

17 THE COURT: Move along.

18 BY MR. GOODSTEIN:

19 Q. Mr. Wheeler, I would like to refer your attention to  
20 Plaintiff's Exhibit 149 for identification. And can you tell  
21 us what this summary that you prepared shows.

22 A. Yes. This is the exact same data you saw on the last  
23 plot, but focused in on that map that we showed earlier that  
24 focuses along the Tennessee/North Carolina border. And here  
25 we can see more clearly the potential benefits of the controls

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1 sought by North Carolina on both Tennessee and many of the  
2 important natural resources in the region, the parks and  
3 Class I areas as well as, you know, state parks and  
4 nonattainment counties which are shown on here as well.

5 Q. Can you tell us a little bit more about the  
6 concentrations that are shown on here and the significance of  
7 those as far as the magnitude of the improvement in annual  
8 PM<sub>2.5</sub> concentrations with these additional controls on TVA's  
9 power plants.

10 A. Yes. The scale is similar to the same one as before. We  
11 see areas where there's more than four-tenths. Large area  
12 extending into North Carolina where it's more than, looks like  
13 more than two-tenths of a microgram. And despite the  
14 assertion that these are small concentrations, when we talk to  
15 health effects and ecosystem experts, they say these are  
16 substantial.

17 MR. FINE: Your Honor, I don't wish to have this  
18 witness testifying about what other people are going to be  
19 testifying.

20 THE COURT: All right. I'll sustain your objection.

21 Q. Mr. Wheeler, from your experience in your 30-plus years  
22 in air quality analysis, what's your conclusion about these  
23 changes?

24 MR. FINE: Your Honor, that's an extraordinarily  
25 open-ended question and I think outside the bounds of this

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1 witness's expertise.

2 THE COURT: Yes, see if you can pin this down a  
3 little more.

4 MR. GOODSTEIN: Thank you, Your Honor.

5 Q. Can you put these changes into context, Mr. Wheeler.

6 A. These concentration -- these differences in concentration  
7 are on the -- you know, on the order of a few percent of the  
8 standard. When I've looked at other areas trying to reach  
9 attainment, we've looked at control strategies that get much  
10 smaller benefits than these and I've -- you know, over the  
11 years I've been in many of the hearings for state  
12 implementation plans and federal implementation plans and we  
13 usually hear that these are small contributions by industry.  
14 What we find, though, is when they're combined with other  
15 control programs, that they can produce substantial benefits  
16 and reach attainment.

17 Q. All right. Mr. Wheeler, we've covered your summaries  
18 regarding the PM<sub>2.5</sub> improvements resulting from the additional  
19 controls sought by North Carolina and on TVA plants and now  
20 I'd like you to go through and summarize the ozone results.

21 MR. GOODSTEIN: And Your Honor, just by way of  
22 explanation, a road map, Mr. Wheeler is going to be presenting  
23 his data and offering it into evidence with this witness since  
24 he was the primary person overseeing the air quality modeling  
25 that was performed, and then we have Mr. Chinkin, his

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1 colleague, who is going to do a little more detailed analysis  
2 and interpretation of the results.

3 THE COURT: All right.

4 Q. Mr. Wheeler, let's go through the ozone plots, if you  
5 will, please. Let's start with Plaintiff's Exhibit 150.

6 A. Yes. With the PM<sub>2.5</sub> plots for these analyses, these  
7 are -- the first four in the set are the peak 8-hour ozone  
8 concentrations on the left for that particular day and on the  
9 right the change in peak 8-hour ozone resulting from the  
10 additional controls. Like the PM<sub>2</sub>, we've selected four  
11 example days to demonstrate the impacts.

12 On this day, May 24th -- we didn't go back into the  
13 winter because ozone tends to be a summertime phenomenon. And  
14 what we see is high ozone concentrations in eastern Tennessee  
15 and western North Carolina and along the coast of the  
16 northeastern portion of the domain.

17 We see that there are benefits emanating from the  
18 control -- the sources that have been controlled, and  
19 extending far out into the -- into Virginia and some as far up  
20 as into West Virginia and Pennsylvania and New York. These  
21 differences are on the order of a maximum of about 9 percent  
22 reduction in peak 8-hour ozone. Those are very close to the  
23 sources.

24 One of the things we notice on ozone versus particulate  
25 matter is we get high concentration -- or we get improvements

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1 immediately downwind of the sources and the amount of  
2 improvement way downwind -- you know, several states is much  
3 less. Where with the sulfate -- with the PM<sub>2.5</sub> and the long  
4 range transport of sulfate, they tend to have broader impacts  
5 further downwind.

6 Q. Let's move through the other days that you've shown in  
7 your figures from your report for ozone. Let's go to  
8 Plaintiff's Exhibit 151, please.

9 A. This is for July 27th. Again, very similar patterns. In  
10 this one we're showing that there would be improvements in  
11 this case, some better than 6 percent improvements in western  
12 North Carolina. And the benefits are extending well downwind  
13 into central North Carolina and Virginia.

14 Q. And Plaintiff's Exhibit 152.

15 A. This is for August 12th. Again, a similar pattern in  
16 this case. As I mentioned, the high pressure moves from day  
17 to day. And we do see some circulation. This is more of a  
18 flow from the south so that the benefits are impacting and are  
19 greatest in Kentucky. One of the things that we do see,  
20 though, is some circulation back in Virginia and back into  
21 North Carolina on the eastern slope of the Appalachian  
22 Mountains.

23 Q. And Plaintiff's Exhibit 153.

24 A. This is for September 4th and this is a -- the prediction  
25 in this case -- this is a different flow pattern. This one

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1 the winds are more from the -- from the north on this  
2 particular day. This appears to be associated with a system  
3 moving through the area, but we still do see benefits  
4 extending down into the south -- to the states to the south of  
5 Tennessee. We also see from the area immediately along the  
6 west -- along the western North Carolina area that we are  
7 seeing impacts of greater than 6 percent improvement -- or  
8 improvements of greater than 6 percent.

9 Q. And Plaintiff's Exhibit 154 for identification.

10 A. Like we did for the daily PM<sub>2.5</sub>, we've calculated the  
11 maximum in percent improvement in peak 8-hour ozone for each  
12 grid cell over the year. So the areas indicated by purple in  
13 this case is that there are some areas in western North  
14 Carolina and surrounding states with more than 10 percent  
15 improvement on at least one day a year.

16 Q. And Plaintiff's Exhibit 155 for identification, can you  
17 tell us what that one shows.

18 A. As we did with the PM<sub>2.5</sub>, we've redisplayed the data  
19 going from a percent basis to a concentration basis. Ozone is  
20 measured in parts per billion or ppb. And here we see areas  
21 in North Carolina that have improvements of 8 parts per  
22 billion or more. And the areas where there is 1 to 2 parts  
23 per billion extend practically up into the states of Virginia,  
24 West Virginia.

25 Q. What do the darkened blue areas on this figure represent?

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1 A. The dark blue indicates that it's greater than 8 parts  
2 per billion improvement resulting from the additional  
3 controls.

4 Q. And what's in the center of those dark blue areas?

5 A. Excuse me?

6 Q. What's in the center of those dark blue areas?

7 A. In the center of the dark blue area are power plants,  
8 generally.

9 Q. All right. And you have a second page to Plaintiff's  
10 Exhibit 155. I'd like you to identify that and explain what  
11 it shows.

12 A. Again, this is a display over the region focusing on  
13 North Carolina and Tennessee and ozone nonattainment areas. I  
14 need to note that all of these may not be accurate at this  
15 time because of recent redesignations.

16 Q. What you're saying is the ozone standards have gone down?

17 A. I'm sorry?

18 Q. What you're saying is the ozone standard has recently  
19 been lowered?

20 A. Well, there's several things that have happened. In some  
21 cases they were not areas designated nonattainment. That came  
22 under a clean air action plan and those were redesignated  
23 recently.

24 But the other issue is that these are the current  
25 implemented air quality standards of nonattainment areas and

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1 based on the 1997 acts. Recent revision to acts for ozone  
2 have reduced the threshold from 85 parts per billion to 75  
3 parts per billion. So many of the areas that aren't currently  
4 nonattainment here will likely be designated nonattainment  
5 when the new NAAQS are implemented.

6 Q. All right. Plaintiff's Exhibit 156 for identification.  
7 Can you take a look at that and tell us what it shows.

8 A. Yes. Similar to the earlier plot, this is a close-up  
9 along the North Carolina/Tennessee border.

10 We see, as mentioned, that some of the largest plants  
11 have a large area of benefit downwind of them: John Sevier  
12 and Widows Creek. But we also see that the improvements  
13 extend throughout this region and they range from 1 part per  
14 billion to greater than 8 parts per billion in certain  
15 locations.

16 There is an area here extending over the North Carolina  
17 border into western North Carolina where these improvements  
18 are between 4 and 8 parts per billion: In the areas near  
19 Asheville, Great Smoky Mountains National Park and several of  
20 the wilderness areas.

21 Q. What does this tell you, Mr. Wheeler, about TVA's  
22 contribution to ozone concentrations in the mountains around  
23 Great Smoky Mountains National Park?

24 A. Well, this indicates -- again, this is not the total  
25 impact. This is just the difference between the base case and

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1 the sought after controls. But it indicates that the impacts  
2 on the parks in this region, this is looking at the maximum  
3 over the course of the year, can be substantial in those parks  
4 and wilderness areas.

5 Q. And the darkened areas around the Widows Creek plant and  
6 the John Sevier plant, what do those indicate on this figure?

7 A. I'm sorry, could you repeat that.

8 Q. The darkened blue areas around the Widows Creek plant and  
9 the John Sevier plant, what do these indicate on this figure?

10 A. Those indicate that the improvement as a result of the  
11 additional controls would be greater than 8 parts per billion.  
12 It also indicates that those areas are affected significantly  
13 by the power plant itself.

14 Q. Mr. Wheeler, I want to turn your attention to  
15 deposition -- now that we've gone through PM<sub>2.5</sub> changes in  
16 concentration resulting from the additional controls and the  
17 ozone changes resulting from the additional controls sought by  
18 North Carolina, I want to have you describe for us the  
19 deposition results. And maybe first can you give us a little  
20 overview of the deposition that is modeled in the CMAQ model.  
21 And we've got a figure out of your report marked as  
22 Plaintiff's Exhibit 157 for identification.

23 MR. FINE: Your Honor, for the record, we would  
24 reinstitute the objection we earlier noted to any testimony  
25 concerning sulfate deposition. I understand Your Honor's

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1 prior rulings, but state it for the record again.

2 THE COURT: You may proceed. Overruled.

3 MR. GOODSTEIN: All right. Maybe before we go  
4 forward with that description, Mr. Wheeler, I'll offer into  
5 evidence, Your Honor, the summaries of the CMAQ modeling that  
6 we just went over sponsored by Mr. Wheeler, Plaintiff's  
7 Exhibits 142 through 149 for identification.

8 THE COURT: All right. Let them be admitted.

9 (Plaintiff's Exhibits Numbers 142 through 149 were  
10 received into evidence.)

11 MR. GOODSTEIN: And the ozone plots that we just  
12 went over with Mr. Wheeler. We offer at this time, Your  
13 Honor, Plaintiff's Exhibits 150 for identification through  
14 157.

15 THE COURT: Let those be admitted.

16 (Plaintiff's Exhibits Numbers 150 through 157 were  
17 received into evidence.)

18 MR. GOODSTEIN: Thank you, Your Honor.

19 Q. Mr. Wheeler, let's talk about deposition. Can you  
20 describe for us, please, the basics.

21 A. Basically. The CMAQ model models deposition. That's the  
22 removal process as I talked about as one of the key processes  
23 in the modeling system.

24 The schematic gives a simple version of what happens in  
25 the atmosphere. As we have already covered, emissions are

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1 emitted. SO<sub>2</sub> and oxides of nitrogen can convert to sulfates  
2 and nitrates. There are many ways which these can be  
3 deposited to the surface and removed from the atmosphere.

4 One process is called dry deposition where gases or  
5 particles simply come in contact with the surface.

6 Another form of dry deposition is inhalation by humans  
7 and animals.

8 They're also respired by plants and that way removed  
9 from the atmosphere.

10 One of the other processes is that these pollutants are  
11 dissolved into cloud water and cloud droplets in the  
12 atmosphere. They undergo some chemical transformations in  
13 that dissolving, and then they can be deposited to the surface  
14 through precipitation. And that's referred to as wet  
15 deposition.

16 So these are the processes by which pollutants in the  
17 atmosphere end up at the surface.

18 Q. And can you now show us your results, Mr. Wheeler, for  
19 the sulfate and the nitrate deposition changes, the  
20 improvements that will result from the individual controls  
21 sought by North Carolina on TVA plants.

22 A. Yes. We prepared two figures in our expert report: One  
23 for sulfate deposition and one for nitrate deposition.

24 Q. All right. I want to show you first Plaintiff's Exhibit  
25 158 for identification. And can you explain to us what that

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1 shows.

2 A. In this plot, similar to the plots we saw for PM<sub>2.5</sub> and  
3 ozone, the figure on the left reflects the total deposition  
4 over the entire year. This -- in this case it's sulfate being  
5 deposited. And from these plots we can see that many areas in  
6 North Carolina are seeing from 10 to 20 -- 10 to 20 kilograms  
7 per hectare deposition over the course of the year. As we  
8 move more into the areas along the Appalachians, particularly  
9 in the western portions up into West Virginia, we see  
10 deposition rates approach -- exceeding 20 kilograms per  
11 hectare. In fact, the maximum deposition here is 52 kilograms  
12 per hectare in these regions.

13 The plot on the right is the change in deposition of  
14 sulfate resulting from the additional controls from TVA  
15 facilities. And there we see that there's large decreases, on  
16 the order of greater than 12 percent with a maximum of  
17 46 percent, within the region in North Carolina, Kentucky and  
18 extending briefly over the ridge into western North Carolina.

19 One of the things we know that there tends to be more  
20 deposition on the upwind side of the Appalachians. Uplifting  
21 up over the mountains causes precipitation and dropping a lot  
22 of the deposition right along the ridgeline.

23 Q. All right. And you also have a plot for nitrate  
24 deposition, I believe identified in Plaintiff's Exhibit Number  
25 159.

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1 A. Yes. And as we've indicated earlier, that sulfate is a  
2 dominant PM<sub>2.5</sub> component in the eastern United States. As a  
3 result, the nitrate deposition patterns look similar to the  
4 ones for sulfate, but they're considerably smaller.

5 In this case the maximum deposition rate, deposition on  
6 an annual basis was 17 kilograms per hectare with -- again,  
7 you can see some high -- higher values greater than  
8 8 kilograms per hectare right along the ridgeline between  
9 North Carolina and Tennessee.

10 In a similar fashion, with the additional controls, the  
11 change in sulfate dep -- I mean, of nitrate deposition focuses  
12 around the power plants. It's not quite as broadly  
13 distributed as the sulfate because a lot of the deposition  
14 occurs closer to the facilities, but we do have some values of  
15 more than a 3 percent decrease in nitrate deposition right  
16 along the Tennessee and North Carolina border. In general,  
17 it's on the order of 1 percent or less through much of the  
18 region.

19 Q. Thank you, Mr. Wheeler.

20 Now, on all of these plots that we've seen for PM<sub>2.5</sub> for  
21 ozone and now for sulfate and nitrate deposition, the  
22 presentation of the improvements on the right side, do they  
23 also show the impacts of TVA's excessive emissions from their  
24 power plants?

25 MR. FINE: Your Honor, again, I'd interpose an

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1 objection to the use of excessive as argumentative.

2 THE COURT: Overruled.

3 A. As I mentioned before, this doesn't show the total  
4 impacts from TVA's power plants, but it's a first order  
5 estimate by the -- looking at the reductions that were taken  
6 with the additional controls. So the actual impacts will be  
7 larger than this.

8 Q. But this shows the impacts, the change resulting from the  
9 additional controls.

10 A. Yes.

11 Q. Mr. Wheeler, I'd like to now turn your attention to your  
12 modeling results for visibility. And if you could give us --  
13 first, before we look at your specific results, could you just  
14 give us an overview of this parameter for air quality  
15 purposes. What is visibility and how does the CMAQ model  
16 project -- simulate visibility changes based on changes in  
17 emissions controls?

18 A. In the most basic terms, visibility is -- affects the  
19 ability of distance and clarity of a view. The key in air  
20 quality models such as CMAQ is that it can estimate the  
21 attenuation and scattering of light which when light is  
22 scattered and absorbed in the atmosphere, the visibility is  
23 reduced.

24 The model does this by looking at distribution of  
25 particles that the model is predicting and we can convert that

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1 to a couple of metrics that indicate visibility. One of those  
2 metrics is a deciview. A deciview is considered a change in  
3 visibility that is perceivable by humans, and that has been  
4 used extensively by EPA and federal land managers as a metric.  
5 The other way to present it in more human terms is visual  
6 range, a representation of how far can you see. And we've  
7 looked at both of those in our analysis of the CMAQ model  
8 output.

9 Q. All right. I'm referring your attention now to  
10 Plaintiff's Exhibit 160 for identification. And can you  
11 identify that and explain what it shows.

12 A. Yes. This is a table from our expert report. The first  
13 analysis we did was to look at several of the Class I areas in  
14 North Carolina and then extending to Shenandoah National Park,  
15 and then added in Washington, D.C., as a distance receptor  
16 source.

17 And what we did is that we looked at the change in  
18 visibility resulting from the additional controls. We took  
19 the part -- the model takes the particle matter, particularly  
20 matter concentrations, and converts those to visual range and  
21 deciviews. And we picked a number of days, which in -- and  
22 these are selected for their maximum impacts, but during 2002  
23 model simulations in each of these areas, the maximum  
24 improvement during the year at that location. For example, at  
25 the Great Smoky Mountains National Park, we looked at

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1 August 19th was the day with the greatest improvement and it  
2 was a 68 percent improvement, from a 15.5 mile visual range in  
3 the base case up to a 26.2 mile visual range in the control  
4 case.

5 We did this for other sites as well. As you can see,  
6 there -- on September 27th at Joyce Kilmer Slickrock  
7 Wilderness, there was a 51 percent improvement in visual  
8 range.

9 At Shining Rock Wilderness, 103 percent improvement in  
10 visual range.

11 At Linville Gorge, a 74 percent.

12 And even in Shenandoah National Park we saw a day when  
13 there was a 23 percent improvement.

14 And 19 percent improvement in Washington, D.C.

15 So these were the worst cases.

16 We also looked at the frequency of occurrence of  
17 improvements in visibility.

18 Q. And how does sulfate from power plants impair visibility?

19 A. As I mentioned, sulfate is the principle predominant  
20 component of  $PM_{2.5}$  in the eastern United States. And sulfate  
21 reduces visibility as a part of the  $PM_{2.5}$ . And when you  
22 reduce sulfur emissions,  $SO_2$ , you reduce sulfate in the  
23 atmosphere, you reduce particle concentrations and you improve  
24 visibility.

25 Q. And did you prepare some other tables presenting

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1 visibility results from your CMAQ model?

2 A. Yes. We did some analysis of the number of days per  
3 year, the frequency of days where perceivable improvement in  
4 visibility might be obtained.

5 Q. Let's look at Plaintiff's Exhibit 161 for identification  
6 next, please, Mr. Wheeler.

7 A. Yes. Exhibit 161 is a table from our report, which  
8 looking at the locations in North Carolina in particular, that  
9 one in seven or one in eight days during the year there would  
10 be a perceivable improvement based on a 1 deciview change in  
11 visibility resulting from the additional controls on TVA  
12 facilities.

13 Q. This shows you frequency of improvement.

14 A. Yes, number of the days and frequencies in terms of how  
15 often. One in eight days. Almost one day a week.

16 Q. And then you also looked at the 20 percent worst  
17 visibility days.

18 A. Yes. It's been noted in the literature that the worst  
19 days are often associated with high concentration -- the  
20 highest concentrations of PM<sub>2.5</sub>.

21 What we did is we looked at the 20 percent -- is that  
22 what I'm looking at?

23 Q. Yes, Plaintiff's Exhibit 162 for identification, I'm  
24 sorry.

25 A. Oh. Yes, we did look at the 20 percent worst days during

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1 the year, meaning the worst visibility based on the CMAQ  
2 estimates of visibility. And what we found at the North  
3 Carolina wilderness sites, that instead of one day a week  
4 there would be improvement, that one in four days or one in  
5 three days would have a perceivable improvement in visibility.

6 Q. And why did you look at 20 percent worst visibility days?

7 A. (No response.)

8 Q. Why did you look at 20 percent worst visibility days?

9 A. Well, a couple of reasons. I started to mention that the  
10 literature indicates that some of the largest improvements can  
11 be achieved on low visibility days. Those are the most  
12 impacted by sulfate. It's also used in the Regional Haze Rule  
13 planning looking at the top 20 percent of days and the lowest  
14 20 percent of days.

15 MR. GOODSTEIN: Your Honor, at this time I offer  
16 Plaintiff's Exhibits 157 through 162 into evidence. And these  
17 are the sulfate and nitrate deposition and visibility plots,  
18 as well as the schematic showing acidification.

19 MR. FINE: Once again, we interpose an objection to  
20 the exhibit dealing with sulfate deposition, Your Honor,  
21 understanding your prior rulings.

22 THE COURT: All right, thank you. The objection is  
23 overruled.

24 (Plaintiffs Exhibits Numbers 157 through 162 were  
25 received into evidence.)

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1 Q. Mr. Wheeler, based on your experience, 30-plus years of  
2 experience in air quality analysis and modeling, how would you  
3 characterize the improvements in visibility that you  
4 summarized for us in your figures from the CMAQ model?

5 A. I would characterize these as substantial.

6 Q. And do you have an overall conclusion based on your  
7 experience about the improvements in air quality throughout  
8 the region and in North Carolina that will result from the  
9 installation of these additional controls on TVA's coal-fired  
10 power plants sought by North Carolina?

11 A. Yes. These improvements that would result from the  
12 additional controls on TVA's plants, ozone, particulate matter  
13 deposition, visibility are all substantial.

14 Q. Mr. Wheeler, have you had an opportunity to review the  
15 expert reports submitted regarding your modeling by TVA's  
16 experts?

17 A. Yes, I have.

18 Q. So you've had a chance to review the reports prepared by  
19 Dr. Tesche and Mr. Mueller, and in particular their comments  
20 about the modeling that you've done on behalf of North  
21 Carolina.

22 A. I didn't hear the last part.

23 Q. The modeling that you've done on behalf of North  
24 Carolina. You've been able to see Dr. Tesche and  
25 Mr. Mueller's comments about the modeling you've done.

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1 A. Yes. They commented that both the modeling that they did  
2 with the base G emissions and the modeling that we -- that  
3 they did and we replicated on the base F emissions were  
4 sufficiently accurate and precise to perform emission control  
5 simulations.

6 Q. Did any of their comments on your modeling change your  
7 conclusions or cause you to modify your results in any way?

8 A. No, not at all.

9 Q. And why not?

10 A. Well, when we looked at what they had modeled, which  
11 there were some -- it's basically the same modeling approach  
12 using the VISTAS modeling system. The main difference is  
13 concerns over what the emissions would be in 2013.

14 When we evaluated their results in a complete context, we  
15 found that they were finding the same results in terms of any  
16 benefit for a particular decrease in emissions. So on a  
17 benefit for reductions basis we were the same. The biggest  
18 difference in their results were how they interpreted their  
19 findings.

20 Q. What about how they presented their findings,  
21 Mr. Wheeler? Did you see a marked difference between their  
22 presentation of results and your own?

23 A. Yes. We looked at their presentation techniques. They  
24 had some criticism of us in terms of our techniques. But we  
25 found that the way that they displayed the benefits of

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1 controls tend to obscure the complete picture of where  
2 benefits might be accrued.

3 Q. And did you look at some of their results reapplied with  
4 some different resolutions?

5 A. Yes, we did. We looked at one of the figures that they  
6 provided in their -- both in their report and executive  
7 summary. They had provided us with their modeling results  
8 from those simulations. So we plotted them with a  
9 finely-resolved non-linear scale. That is typically used in  
10 analysis of air quality data.

11 Q. And when you replotted Dr. Tesche and Mr. Mueller's  
12 results using a finely-resolved non-linear scale, what did it  
13 show?

14 A. It showed that there was impacts or benefits to be  
15 obtained through most of the modeling domain.

16 Q. I'd like to show you Plaintiff's Exhibit 165 for  
17 identification, and can you identify that and explain to us  
18 what it shows.

19 A. Yes. This is from our supplemental report. On the left  
20 is a copy of the figure from their report based on their TVA  
21 plan that they used in their modeling to get the 2013 base.  
22 We disagreed with that because it included controls that  
23 weren't on the books.

24 MR. FINE: Your Honor, before we proceed with this,  
25 I'll have to render an objection -- make objection to the

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1 legend that appears within the body of this exhibit. It's  
2 difficult to read on the screen, but based on -- it reads,  
3 "Based on Tesche and Mueller's simulation to TVA's TCS plan,  
4 which is unlikely to be implemented as proposed and which  
5 included errors in emission inputs." I would suggest that  
6 that is argumentative and inappropriate and also inaccurate  
7 based on Dr. Staudt's own testimony.

8 THE COURT: Now, which exhibit are you referring to?

9 MR. FINE: This is Plaintiff's Exhibit marked for  
10 identification 165.

11 THE COURT: All right.

12 MR. FINE: And there's a legend in red that appears  
13 on both sides of the exhibit which is argumentative at best  
14 and inaccurate at worst based on Dr. Staudt's own testimony  
15 concerning TVA's going forward with additional controls,  
16 particularly at the Bull Run steam plant, the Kingston steam  
17 plant, and the fuel switch at the Johnsonville steam plant,  
18 and the upgrade from Dr. Staudt's estimation of the  
19 performance of the scrubber at Paradise unit 3.

20 MR. GOODSTEIN: Your Honor, this figure is in  
21 Mr. Wheeler and Mr. Chinkin's report just like this. And we  
22 can take some testimony on this legend, but the background on  
23 it, Your Honor, is we're trying to show the different  
24 presentation scales and how Dr. Tesche and Mr. Mueller, TVA's  
25 modelers, used a scale that tends to underestimate the

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1 benefits of the pollution controls. So --

2 THE COURT: That will be for the purpose of cross  
3 examination. If it's shown to be false, of course, the court  
4 won't consider it.

5 MR. GOODSTEIN: Thank you, Your Honor.

6 THE COURT: What you're saying is that the experts  
7 don't agree with each other, and I don't expect them to.

8 MR. GOODSTEIN: Not much of a surprise.

9 Thank you, Your Honor.

10 THE COURT: All right. Go ahead with your  
11 examination.

12 BY MR. GOODSTEIN:

13 Q. All right. Mr. Wheeler, when you were able to replot  
14 Dr. Tesche and Mr. Mueller's presentation of this data, what  
15 did it show?

16 A. Yes.

17 Q. What did it show when you were able to replot it?

18 A. Well, I think at first after we looked at our analysis,  
19 it really stood out when we looked at Tesche and Mueller's  
20 plot that there appears to be no impact or very little impact  
21 outside the state of Tennessee. When we replotted, we find  
22 that there are differences extending throughout the modeling  
23 domain, albeit at low values, but those values are considered  
24 significant by the users of this model output.

25 I think as a data analyst, we always try to show the full

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1 set of data that describes the distribution of concentrations  
2 throughout a region.

3 We also realize that the distribution of air quality, of  
4 pollutants in the atmosphere is not linear and that there are  
5 gradients that extend for long distances away from sources.

6 Q. How would you describe the presentation by Dr. Tesche and  
7 Mr. Mueller?

8 A. I'm sorry?

9 Q. How would you describe the presentation by Dr. Tesche and  
10 Mr. Mueller?

11 A. I would describe it as being -- trying to obscure some of  
12 the results.

13 Q. And I'd like to show you Plaintiff's Exhibit 164 for  
14 identification. And can you tell us what that figure shows.  
15 In this figure -- these are our data from our simulation, the  
16 difference between our base case and control scenario.

17 On the right is the plot of the differences based on our  
18 non-linear finely-resolved scale. This is what we presented  
19 in our report.

20 If we look at the left is on the scale that Dr. Tesche  
21 and Mr. Mueller used in their report. And while our area of  
22 benefit is much larger because we assumed a larger difference  
23 between the base case and the control case, there appears to  
24 be areas that clearly have some benefits in our plot that are  
25 not seen in the alternate presentation on the left.

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1 Q. So similar type of presentation by Dr. Tesche and  
2 Mr. Mueller of these results.

3 A. I'm sorry?

4 Q. It's a similar type of presentation of the results as we  
5 saw in the previous figure --

6 A. Yes, it is.

7 Q. -- by Dr. Tesche and Mr. Mueller.

8 A. Yes.

9 Q. And how would you describe this presentation result?

10 A. This meaning?

11 Q. Dr. Tesche and Mr. Mueller's presentation of results on  
12 the left side of this figure.

13 A. It doesn't give the complete picture of what's going on.  
14 If I turn this over to a health effects expert to look at and  
15 they get the impression that there was no impact --

16 MR. FINE: Your Honor, I would object to his  
17 testimony as to what a health effects expert would or would  
18 not derive from this information. It's outside his area of  
19 expertise.

20 THE COURT: Overruled.

21 Q. So in summary, Mr. Wheeler, what did you take away from  
22 the comments in Dr. Tesche and Mr. Mueller's report about your  
23 presentation of data and your use of a non-linear scale?

24 A. What I took away was it was obvious that they were either  
25 obscuring information or they were unknowledgeable about data

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1 analysis techniques.

2 Q. And can you describe for us what is a finely-resolved  
3 non-linear scale and why is that appropriate presentation of  
4 this type of data?

5 A. It is comprehensive in terms of the contribution -- the  
6 benefits throughout the region. This is a technique that is  
7 routinely used to display measured air quality data and --  
8 that's all I can say.

9 Q. You also recall the comments by Dr. Tesche and  
10 Mr. Mueller in their reports about the uncertainty --

11 A. Yes.

12 Q. -- of CMAQ model simulations. Did that discussion cause  
13 you to change your analysis?

14 A. No, it didn't.

15 Q. And why not?

16 A. Well, we're working with a modeling system that's been 30  
17 years in development. I had some concerns about uncertainty  
18 20 years ago, but there's been a constant effort to improve  
19 the modeling systems to make them more comprehensive, more  
20 reliable.

21 In using these systems, I don't see the uncertainties  
22 that Dr. Tesche and Mr. Mueller described. In fact, in one  
23 sentence they say that it's acceptable -- appreciably  
24 significantly precise and accurate for the type of modeling,  
25 but then they say you've got to be careful about the

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1 uncertainties. They also go on to misquote some of the work  
2 of Dr. Hanna and myself on that topic of uncertainty, and I  
3 think we're at a point in model development that these are  
4 extremely reliable, precise and accurate tools and that  
5 uncertainty is not a significant issue in the use of them the  
6 way we did.

7 Q. And in the type of analysis that you've done here where  
8 you compare -- I'm sorry -- when you compare scenarios with  
9 and without additional controls in a model year, how would you  
10 describe the precision of the CMAQ model?

11 A. I am very comfortable in describing the precision down to  
12 a hundredth of a unit, even a part per million or microgram of  
13 cubic meter. I've done studies looking for the presence of  
14 numerical noise in the simulations resulting from differences,  
15 such as the base case and the control case, and I don't see  
16 any noise simulations extending out to six or seven decimal  
17 places.

18 I've also looked at the changes in air quality downwind  
19 of sources that have been controlled in the model and they're  
20 completely consistent physically and chemically in terms of  
21 the response downwind, even to very low levels such as a  
22 tenth -- I mean, to a hundredth of a microgram or part per  
23 billion. In fact, I've read several reports by Dr. Tesche  
24 that also report response down to that level.

25 Q. And this is the CMAQ modeling approach that was used in

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1 the VISTAS program?

2 A. I think they may have used CAMX in those cases.

3 Q. I'm sorry. You testified earlier that the CMAQ model was  
4 used in VISTAS.

5 A. Yes.

6 Q. So you used that VISTAS version of CMAQ. That's where  
7 you received your modeling --

8 A. Yes, I did.

9 Q. -- inputs.

10 A. Yes.

11 Q. All right.

12 MR. GOODSTEIN: No further questions of this witness  
13 at this time, Your Honor.

14 THE COURT: All right. Mr. Fine, we'll take our  
15 recess and then you may proceed.

16 MR. FINE: Thank you, Your Honor.

17 (Brief recess at 4:02 p.m.)

18 MR. FINE: Thank you, Your Honor.

19 THE COURT: Yes.

20 NEIL WHEELER

21 CROSS EXAMINATION

22 BY MR. FINE:

23 Q. Mr. Wheeler, before we get going, I know this is probably  
24 not going to be as exciting as chasing tornados, but  
25 ultimately probably less raising of blood pressure, too.

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1 A couple preliminary questions just to make sure or, if  
2 you will, housekeeping matters.

3 Do you still have the book in front of you that your  
4 attorneys were so kind enough to put together --

5 A. Yes, I do.

6 Q. -- with your exhibits?

7 And another thing is if you cannot hear my questions -- I  
8 know you and Mr. Goodstein were having some problems. If you  
9 can't hear my questions, please let me know.

10 A. I will.

11 Q. Thank you. I'm not a quiet person as a general rule and  
12 I'll try and make myself heard.

13 Mr. Wheeler, you mentioned Dr. Tesche in your testimony  
14 both in terms of his involvement with the VISTAS program and,  
15 of course, his involvement with TVA modeling in this case.  
16 That's correct?

17 A. (No response.)

18 Q. That's true, is it not?

19 A. I didn't quite hear you. What was it?

20 Q. I'm sorry, sir.

21 A. Yeah.

22 Q. You did mention Dr. Tesche both in terms of his  
23 involvement with VISTAS and his involvement with the modeling  
24 for TVA in this case.

25 A. Yes.

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1 Q. And you would agree with me, would you not, that he is an  
2 experienced atmospheric modeler.

3 A. Yes.

4 Q. And has done extensive work both developing and running  
5 atmospheric models.

6 A. He has -- was involved early in his career in  
7 development. He's currently involved in applying.

8 Q. And interpreting the results of -- from atmospheric  
9 models, correct?

10 A. Yes.

11 Q. And he has, to your knowledge, an extensive publication  
12 history, does he not?

13 A. Yes.

14 Q. I believe you've already discussed his work with the  
15 VISTAS program. I'm correct, am I not, that the State of  
16 North Carolina was extensively involved with VISTAS, was it  
17 not?

18 A. Yes, North Carolina was a participant in VISTAS.

19 Q. In fact, wasn't a member of the staff of the Division of  
20 Air Quality, Sheila Holman, one of the people principally  
21 involved with VISTAS?

22 A. Yes, she was.

23 Q. And you would agree with me, would you not, that  
24 Dr. Tesche has done work for other governments and government  
25 consortiums in the atmospheric modeling arena?

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1 A. Yes.

2 Q. Mr. Wheeler, I appreciate your discussion and description  
3 of the CMAQ model, C-M-A-Q model. There is another model that  
4 has been used in the modeling in this case, CAMX, C-A-M-X.

5 A. Yes.

6 Q. Sir, you would agree with me, would you not, that CAMX is  
7 also a state-of-the-science atmospheric modeling tool?

8 A. Yes, both CAMX and CMAQ are state-of-the-science tools.  
9 They are both widely used in the United States. There are  
10 some differences between them, but they are both reasonably  
11 good tools.

12 Q. In fact, the Environmental Protection Agency has used  
13 both of those tools, has it not?

14 A. Yes, they have.

15 Q. And if you'll bear with me just for a few moments longer.  
16 It's my understanding, and correct me if I'm wrong, that CAMX  
17 has a couple, what I call probing tools that go by -- at least  
18 the ones I would like to discuss with you go by the initials  
19 PSAT and OSAT.

20 A. Yes, I'm familiar with those.

21 Q. And could you, just for the sake of the court reporter  
22 and the court, tell us what PSAT is.

23 A. PSAT is Particulate Source Apportionment Tool.

24 Q. And what is OSAT?

25 A. Ozone Source Apportionment Tool.

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1 Q. Mr. Wheeler, the PSAT and OSAT tools for CAMX, would you  
2 agree with me that they allow an investigator to study  
3 contributions of particular sources to particulate matter and  
4 ozone?

5 A. Yes. They're a screening tool for source apportionment.  
6 Not as accurate as direct sensitivity analysis.

7 MR. FINE: Your Honor, if I could approach the easel  
8 for a brief moment, I'll try and be quick.

9 THE COURT: All right, sir.

10 MR. FINE: Madam court reporter, I apologize, I'm  
11 going to be behind you for a few minutes.

12 THE COURT REPORTER: I can hear you fine.

13 Q. Mr. Wheeler, if you would do me the kindness, sir, of  
14 looking at Plaintiff's Exhibit 138 which I believe is in your  
15 book.

16 A. 138?

17 Q. Yes, sir. Do you have that in front of you?

18 A. I do.

19 Q. And if I understood your testimony, this was one -- this  
20 was some of the information that Dr. Staudt provided to you  
21 for your modeling.

22 A. No, that's not correct. This was provided by North  
23 Carolina. It was in the 2005 report on the Clean Smokestacks  
24 Act.

25 Q. I beg your pardon, sir. I appreciate the correction.

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1        If you will bear with me, Mr. Wheeler, I would like to  
2   use Plaintiff's Exhibit 138 as you have described its source  
3   for a very quick geography exercise. If will you bear with me  
4   and take a look at the map that has been placed back on the  
5   easel. I apologize for the smallness of the print, but  
6   perhaps the two of us working together can work through it.

7   A.    Okay.

8   Q.    The first plant that's listed on Plaintiff's Exhibit 138  
9   is the Asheville plant. The denominee there is Carolina Power  
10   and Light, CP&L. Do you see that, sir?

11   A.    Yes.

12   Q.    And I believe that's now Progress Energy.

13   A.    Correct.

14   Q.    And then the next plant that's listed is again another  
15   Progress plant, CP&L plant, Mayo.

16   A.    (Affirmative nod.)

17   Q.    And I believe that's up close to the border with  
18   Virginia; is that correct, sir?

19   A.    Yes.

20   Q.    Towards the -- a little bit to the east of the center of  
21   the -- of that state line between Virginia and North Carolina.  
22   Would that be correct?

23   A.    Appears to be correct.

24   Q.    And then the next plant that's listed again for Progress  
25   Energy is the Roxboro plant; is that correct, sir?

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1 A. Yes.

2 Q. And that's a little bit to the west of the Mayo plant.

3 A. Yes.

4 Q. And then I'm following the list as it appears on  
5 Plaintiff's Exhibit 138, and we're going to jump around a  
6 little on the map. But the next plant that's listed is one of  
7 Duke Power's or Duke Energy's plants, the GG Allen plant.

8 A. Yes.

9 Q. And that's down near the Charlotte, North Carolina, area  
10 close to the South Carolina border.

11 A. Yes.

12 Q. And then the next plant that's listed is Duke's Buck  
13 plant which is very much almost in the geographic center of  
14 North Carolina if I'm any judge. Would that be correct, sir?

15 A. That's approximately correct.

16 Q. And then the Cliffside plant about which we've already  
17 heard some testimony today is another one of the Duke plants a  
18 bit west of Gastonia and Charlotte, again on the South  
19 Carolina border.

20 A. Yes.

21 Q. Is that correct?

22 And then we have the Dan River plant for Duke, and we're  
23 jumping back up to the -- near the border with Virginia. This  
24 is in Rockingham County. You see where the Dan River plant is  
25 located?

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1 A. Yes.

2 Q. And then we have the Marshall plant for Duke located here  
3 right near Catawba County. Sort of in south central North  
4 Carolina.

5 A. I see that.

6 Q. All right, sir. And then we have Duke's Riverbend plant  
7 which is just to the northwest of the Charlotte area here in  
8 south central North Carolina. Do you see that, sir?

9 A. Yes.

10 Q. And then we have the Sutton plant which I believe is a  
11 Progress Energy plant though it's not listed as such. That's  
12 down near Wilmington; is that correct, sir?

13 A. That appears to be correct.

14 Q. And we have, then, another Progress plant, the Cape Fear  
15 plant, which is back up towards the -- up towards the Raleigh  
16 area just to the southwest or so of Raleigh; is that correct,  
17 sir?

18 A. That appears to be correct.

19 Q. And we have the Lee plant from Progress is in east  
20 Carolina in Wayne County. That's another Progress plant right  
21 there in the eastern part of North Carolina.

22 A. Yes.

23 Q. All right, sir. And finally, in terms of the Progress  
24 and Duke plants, we have the WH Weatherspoon plant for  
25 Progress which is here in Robeson County -- I may be

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1 mispronouncing that -- down in sort of what I think of as the  
2 southeastern part of North Carolina not too far from the South  
3 Carolina border; is that correct, sir?

4 A. Yes.

5 Q. And are you familiar with the Blue Ridge Paper facility  
6 in Canton?

7 A. Yes, I am.

8 Q. And that's just to the west here of Asheville.

9 A. Yes.

10 Q. All right, sir. Before I leave this little station, let  
11 me ask you a few questions concerning your isosurface  
12 visualization of SO<sub>2</sub> emissions. I'm not going to ask you to  
13 replay the movie at this point in time, but just so it's clear  
14 in the record, this is not just simply TVA's SO<sub>2</sub> emissions.

15 A. That's correct.

16 Q. In fact, we're plotting, it would appear to me, plumes  
17 from the panhandle of Florida, southern Alabama, southern  
18 Mississippi, looks to be perhaps the Birmingham, Alabama, area  
19 in Alabama, and then other sources in Florida, Georgia and  
20 South Carolina, and some sources, frankly, I'm not sure which  
21 states they're in. The state boundaries are obscured. Is  
22 that correct, sir?

23 A. That's correct.

24 Q. Thank you.

25 You would agree with me, would you not, that the modeling

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1 process depends to a large extent on the accuracy of the  
2 inputs into that model?

3 A. Yes.

4 Q. I believe you testified in response to some of  
5 Mr. Goodstein's questions that you took some care and  
6 attention in terms of making sure that the inputs were  
7 correct, particularly the meteorological inputs.

8 A. That's correct.

9 Q. And of course, one of the more important aspects of the  
10 inputs would be the actual inventory of emissions; is that  
11 correct?

12 A. Yes.

13 Q. And I believe that I'm correct in stating that under  
14 EPA's general guidance for modeling, one of the things that  
15 you're supposed to do for future years is to do a careful  
16 assessment of what additional controls might be placed on a  
17 particular power plant between the base year and the future  
18 year.

19 A. As I noted earlier, that the first stage is to apply  
20 appropriate controls based on controls that are on the books  
21 and attempt to put those appropriately, yes.

22 Q. Let me just make sure that I'm being clear with you, sir.  
23 What I'm trying to focus on is if you have -- if you're  
24 looking at an emissions inventory for, let's use the case  
25 we're talking about here, base case year of 2002 and you're

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1 looking at your future year in terms of adding additional  
2 controls of 2013. Wouldn't it be appropriate to make sure  
3 that the controls that are going to be installed between 2002  
4 and 2013 are accurately reflected in your projections for  
5 2013?

6 A. Yes, to the extent possible.

7 Q. Bear with me, sir, I'm going to be jumping around a  
8 little and I'll try and be as clear as I can be and also as  
9 quick as I can be.

10 I believe, sir, that you testified in your direct  
11 testimony, and in fact, as is reflected in the documents that  
12 have been tendered into evidence, that your source for the  
13 emissions information for TVA for 2013 came from Dr. Staudt.

14 A. Yes, that is correct.

15 Q. So if Dr. Staudt -- let me again, so it will just be  
16 clear in my own mind if nothing else. What you were looking  
17 at in your comparisons was a comparison between what  
18 Dr. Staudt said was the base case for TVA in 2013 and what  
19 Dr. Staudt said would be the case for TVA with the additional  
20 controls sought by North Carolina in this instance.

21 A. The impact -- the magnitude of the cap is the difference  
22 between that, is what we're really modeling -- comparing  
23 between the 2013 base and the control scenario. It's the  
24 sought after controls.

25 Q. I'm sure it is due to my own fuzziness of brain,

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1 Mr. Wheeler, but bear with me for a moment while I try to  
2 understand exactly what you're telling me.

3 As I understood it, and you may need to correct me. As I  
4 understood it, what you were comparing -- let me just back up  
5 and try and be coherent.

6 Dr. Staudt gave you a set of numbers where he thought  
7 that that's what TVA would be emitting from its power plants  
8 in 2013 if nothing further was ordered by this court.

9 A. That's correct.

10 Q. He also gave you a set of numbers based on his  
11 assumptions as to what TVA's emissions would be in 2013 with  
12 the additional controls sought by North Carolina in this case.

13 A. That is correct.

14 Q. And so the comparisons that you were running through  
15 your -- with your modeling was comparing the impacts from  
16 Dr. Staudt's base case versus what Dr. Staudt was proposing as  
17 the control case for 2013.

18 A. Yes.

19 MR. FINE: Excuse me, Your Honor, I'm not  
20 communicating well with my team. If I could ask my colleague  
21 Ms. Gillen to please display Plaintiff's Exhibit Number 54 on  
22 the monitor, I would be in her debt even more so than I am  
23 already.

24 Q. Mr. Wheeler, I believe that you were in the courtroom  
25 when Dr. Staudt was testifying concerning Plaintiff's Exhibit

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1 Number 54.

2 A. I believe so, but I can't be certain. This was not --

3 Q. All right, sir. I'm sorry.

4 A. I didn't catch all of Dr. Staudt's testimony.

5 Q. Very well, sir. Then I will proceed accordingly.

6 I'm looking particularly, Mr. Wheeler, at the -- at  
7 Dr. Staudt's 2013 base case numbers for sulfur dioxide, SO<sub>2</sub>.  
8 Do you see that column?

9 A. Yes.

10 Q. And Dr. Staudt's totals for SO<sub>2</sub> in his 2013 base case  
11 for -- again, for SO<sub>2</sub>, totaled nearly 449,000 tons; is that  
12 correct, sir?

13 A. That's what is shown there.

14 Q. And correct me if I'm wrong, but it's my understanding  
15 that in terms of the TVA system, that that 449,000 tons of SO<sub>2</sub>  
16 was what you used, you and Mr. Chinkin and your colleagues at  
17 STI used for the modeling concerning sulfate that TVA will be  
18 emitting in 2013.

19 A. Yes.

20 Q. And of course, when we're talking about SO<sub>2</sub>, we're  
21 talking about a pollutant that contributes to a number of what  
22 I'll call results in the atmosphere, such as PM<sub>2.5</sub>, sulfate  
23 deposition in the form of acid deposition, and visibility  
24 impacts, correct?

25 A. That's correct.

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1 Q. And in looking at this -- at the Plaintiff's Exhibit 54,  
2 let me just ask you this question. It would affect your  
3 modeling for SO<sub>2</sub> and its -- I guess its consequences such as  
4 PM<sub>2.5</sub>, sulfate and visibility impacts, it would affect your  
5 modeling if we took away some 138,000 tons of SO<sub>2</sub> from  
6 Dr. Staudt's base case.

7 A. What we were trying to model was a cap, not what might  
8 happen. So the difference between the base case and the  
9 control case is the level of controls sought by North  
10 Carolina.

11 Q. Mr. Wheeler --

12 A. Not what may have happened after the time we did that  
13 modeling.

14 Q. Mr. Wheeler, let me reask my question because I'm afraid  
15 that I wasn't clear enough and I don't believe that you  
16 answered it.

17 What I'm just asking you, sir, as a highly competent,  
18 very experienced atmospheric modeler, would removing some  
19 138,000 tons of SO<sub>2</sub> from the equation affect your modeling for  
20 SO<sub>2</sub> and its effects in the atmosphere?

21 A. It would if that's the objective we were looking at is to  
22 look at a scenario where there were different emissions. If  
23 that were taken out, as I understand, that would be included  
24 in the cap. So, yes, changes in emissions do affect air  
25 quality.

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1 Q. And they would affect your modeling.

2 A. Models predict changes in air quality based on changes in  
3 emissions.

4 Q. All right, sir. But if I understood your previous  
5 testimony in response to one of my earlier questions, what  
6 much of your modeling was looking at was the difference  
7 between Dr. Staudt's 2013 base case and what is labeled here  
8 on Exhibit 54 as Dr. Staudt's 2013 CSA-equivalent case.

9 A. That's what we were modeling, yes.

10 Q. All right, sir. Mr. Wheeler, I think you answered some  
11 questions for Mr. Goodstein concerning uncertainty.

12 A. Yes, sir.

13 Q. And your level of confidence in the results from your --  
14 from the CMAQ modeling.

15 A. Yes, I did.

16 Q. It's true, is it not, that atmospheric modeling results  
17 do have a range of uncertainty?

18 A. There are uncertainties in all things, including modeling  
19 results.

20 Q. And you'd agree with me that atmospheric chemistry which  
21 the modeling systems are trying to illustrate is very complex.

22 A. And very comprehensive.

23 Q. And you would also agree with me that the atmospheric  
24 models such as CMAQ rely on inputs about weather conditions.  
25 That's correct?

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1 A. That's correct.

2 Q. And emissions both manmade and natural.

3 A. Yes.

4 Q. That's correct?

5 And that both the inputs about weather conditions and  
6 emissions can lead to possible errors in projecting impacts  
7 from emissions.

8 A. Well, we have to understand how these are used in future  
9 year simulations. When we look at two scenarios like the base  
10 case in 2013 and then the control case, that all of the  
11 uncertainties that were in the original emissions inventory in  
12 meteorology are the same. So that cancels out a lot of the  
13 uncertainty in the response of the model to emission  
14 reductions.

15 Q. Let me just be sure that I'm clear and that I'm  
16 understanding you. What you're telling me is that the  
17 uncertainties inherent in atmospheric modeling are reduced but  
18 not canceled out when comparing two future cases assuming  
19 different control regimes.

20 A. I couldn't quite follow that description, but, yes, we  
21 can use these for controls and that is why we do the model  
22 performance evaluation to understand that even with  
23 uncertainties in the modeling system, that is within that band  
24 of acceptable performance which tells us that the system, the  
25 chemistry, the physics are operating sufficiently to be used

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1 for emissions control comparisons.

2 Q. Let me try this again, Mr. Wheeler. When you're looking  
3 at and you're comparing two future cases assuming different  
4 control regimes, I think it's true to say that the  
5 uncertainties in your view may be reduced. But I would also  
6 be correct in saying that they are not completely canceled  
7 out.

8 A. I would say that at a very high level, 95th percentile  
9 level or more, that the uncertainties based on my experience,  
10 that if there are some, they tend to bias the model towards  
11 underestimating response to emission reductions so that when  
12 we do an assessment like this, the benefits to be accrued from  
13 additional emission controls may be actually underestimated,  
14 and that's where the uncertainty lies.

15 Q. Mr. Wheeler, I'd like to draw your attention, if I could,  
16 to a document that's been previously introduced into evidence.  
17 That's Plaintiff's Exhibit 132, which I believe is, again, in  
18 the book in front of you. It's the bugle chart or graph.

19 A. What was the number again?

20 Q. 132. It's what I think you referred to as a bugle graph.

21 A. Okay. I'm having difficulty locating it. I'm familiar  
22 with it, but I go in my book from 100 --

23 Q. The numbers are not quite in order.

24 A. Okay. Let me look back.

25 Q. I think they're in order of your testimony.

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1 A. I found it, yes.

2 Q. I think this was Mr. Goodstein's organization and it  
3 might be a bit confusing.

4 All right, sir. You have that in front of you.

5 A. Yes, I do.

6 Q. And just so that it's clear in the record, I notice on  
7 the right-hand side of the page, there is a, I guess a legend  
8 for the various monitoring sites that were used for this  
9 analysis.

10 A. These are actually -- these were performed by VISTAS and  
11 these are four different monitoring networks.

12 Q. And that would be the Improved Network, the STN Network,  
13 the Search Network, and the Cast Net Network.

14 A. That's correct.

15 Q. And just looking at this bugle graph, it would appear to  
16 me that there was even some disagreement among the actual  
17 monitors in the field.

18 A. That's correct.

19 Q. I believe that related to your point that there's  
20 something of a disconnect, my term, between modeling results  
21 and what actual field measurements you might obtain.

22 A. That's correct.

23 Q. I believe that you said that you -- a model might not be  
24 able to predict what you might measure on the tabletop in  
25 front of you.

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1 A. That's correct.

2 Q. If I could ask you to turn to the document you testified  
3 about that has been introduced into evidence as Plaintiff's  
4 Exhibit 139. These are the inert tracer plots.

5 A. Yes.

6 Q. And again, just so it's clear, inert tracer plots do not  
7 measure air quality impacts, do they?

8 A. I'm sorry?

9 Q. Inert tracer plots do not measure actual or even -- well,  
10 let me back up and start over.

11 Inert tracer plots do not measure air quality impacts.

12 A. I still didn't quite follow what you're...

13 Q. Inert tracer plots do not measure air quality impacts.

14 A. That's correct, as I testified.

15 Q. All right. And again, they are merely a tool to see if a  
16 source could possibly impact a receptor.

17 A. I said that as well, yes.

18 Q. All right, sir. Now, I think you probably heard me say  
19 this when I objected to it, but wouldn't it be a fair  
20 statement that inert tracer plots really do not show anything  
21 more than how the prevailing winds blow?

22 A. It's somewhat like that. We think of these as trajectory  
23 plots that are often used in air quality analysis with  
24 dispersion. So it's a little bit more than just a wind  
25 climatology. It looks at three-dimensional variations in wind

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- 1 and how those might be transported.
- 2 Q. Why the use of parts per trillion?
- 3 A. We put these in -- if you were to take and put SO<sub>2</sub> into a
- 4 model and run it out for an entire year, the concentrations
- 5 would average over the region would be in parts per trillion.
- 6 If it was an inert species, that is.
- 7 Q. And just so that it's clear in the record, I'm looking at
- 8 the scale that appears on the left side of the inert tracer
- 9 plots.
- 10 A. Yes.
- 11 Q. And the scale moves in what I will call a non-linear
- 12 fashion.
- 13 A. That's correct.
- 14 Q. So that we have zero to 5 and then the next jump is 5 to
- 15 20 and then 20 to 40, and if I'm reading the number correctly,
- 16 40 to 80.
- 17 A. Yes.
- 18 Q. And what's the top of the scale, if you know?
- 19 A. It's greater than 80. In this particular simulation, if
- 20 you were to look at the bottom of the chart, it gives you the
- 21 minimum and maximum values in the domain. In this case it was
- 22 2,429 micrograms -- I mean, ppt of tracer material.
- 23 Q. And that's somewhere off in the greater than --
- 24 A. Actually, it's probably near the source.
- 25 Q. All right, sir. Help me, if you would, Mr. Wheeler.

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1 Where in your reports did you use the results from these inert  
2 tracer plots?

3 A. I used this just in terms of a general interpretation of  
4 the patterns of transport from individual power plants, what  
5 they might look like.

6 Q. Is that discussed in your -- in either of your reports?

7 A. I'm sorry?

8 Q. Is that discussed in either of your reports?

9 A. No, it's not.

10 Q. Did the tracer results alter in any way how you set up or  
11 exercised the CMAQ model?

12 A. No. They verified the setup of the CMAQ model.

13 Q. Did the tracer results alter in any way how you analyzed  
14 the results of the full chemistry CMAQ simulations that you --  
15 that you ran?

16 A. In terms of my findings, they were helpful in  
17 understanding the full chemistry simulations and where the  
18 regions of impact might be from individual facilities. As you  
19 know, we modeled all of TVA's facilities jointly.

20 Q. Is that discussed in either of your reports?

21 A. No, I don't believe so.

22 Q. Did you use the tracer results to select concentration  
23 intervals for plotting any of the CMAQ gas phase or aerosol  
24 model output?

25 A. In a way we did. It gave us some in our initial

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1 plotting, and realizing that there are strong non-linear  
2 ingredients within the model and the domain. As a result of  
3 these plots, we analyzed each of the full chemistry plots by  
4 looking at the range of values in the modeling domain and  
5 picking appropriate scales to depict the full range of  
6 concentrations and impacts.

7 Q. Again, sir, is that discussed in either of your reports?

8 A. No.

9 Q. And I believe in your direct testimony when you said --  
10 you were describing the inert tracer plots, you're saying this  
11 is an entirely nonreactive tracer. I mean, that's, I guess,  
12 what inert means.

13 A. That's what it means.

14 Q. So it doesn't have any particular molecular weight.

15 A. I believe it may, if we picked SO<sub>2</sub> as a surrogate for it.

16 Q. Is that indicated in the report?

17 A. No, it's not.

18 Q. So if you were picking SO<sub>2</sub> -- if you were picking sulfur  
19 dioxide, SO<sub>2</sub>, as a surrogate, would that be buoyant or heavier  
20 than air?

21 A. Well, it would be treated the same way as all of the SO<sub>2</sub>  
22 emissions from point sources.

23 Q. But again, your report doesn't discuss the fact that you  
24 were using SO<sub>2</sub> as a surrogate for the inert tracer.

25 A. I -- I'd have to check my report. I think we did say

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1 that it was -- the tracers were proportional to the SO<sub>2</sub>  
2 emissions.

3 Q. Did you evaluate the performance of the CMAQ model to  
4 assess its accuracy and precision in simulating the tracers  
5 you used?

6 A. No, not with the tracers. Obviously, we didn't have  
7 measurements of tracers. This is a standard technique for  
8 looking at transport potential.

9 Q. So under that circumstance, how do you know that the CMAQ  
10 concentration fields for each of the 11 tracer plots bear any  
11 resemblance to chemical species?

12 A. I don't think we intended to say that they represented  
13 chemical species. I think what we said is these would show  
14 the potential for transport in the modeling domain. It's a  
15 first order screening analysis, as we said.

16 Q. All right, sir. Did you run any tracer plots for the  
17 North Carolina plants we discussed a little earlier in your  
18 testimony?

19 A. No, that was not the focus of our modeling effort.

20 Q. Let's spend a few moments talking about what we've  
21 been -- at least what I've been describing as the sulfate  
22 movie. We've already had some testimony about that. And I'm  
23 looking particularly at what I'm going to call the screen shot  
24 from the sulfate movie that's displayed on the easel.  
25 Plaintiff's Exhibit 140 if you want to look at it more close

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1 up.

2 Do you have that in front of you, sir?

3 A. I do.

4 Q. Now, as I understand it, this -- the movie that we saw,  
5 as demonstrated by the screen shot that appears in Plaintiff's  
6 Exhibit 140, does not show concentrations of either sulfur  
7 dioxide or sulfate.

8 A. No. This was intended to demonstrate the processes are  
9 three dimensional and that chemical transformations do occur  
10 both at the surface and aloft in models. This is direct  
11 output from our 2013 CMAQ simulation. It is qualitative.

12 Q. You're saying demonstrate the -- excuse me, I apologize.  
13 The hour grows late and my tongue grows thick.

14 You talk about the vertical component of the  
15 transformation of sulfur dioxide into sulfate, correct?

16 A. Yes.

17 Q. But there is no vertical scale provided in this  
18 presentation, is there?

19 A. Not on this particular plot, but it is on other -- other  
20 views that we showed. There's a bounding box that shows the  
21 vertical extent.

22 Q. In the movie that we played here earlier this afternoon?

23 A. I believe so, the ones that are angled. I'd have to go  
24 back and look at that. We generally look at the entire  
25 domain.

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1 Q. That would be sort of the -- and I'm going to -- this is  
2 my characterization of it. As if I was afloat out over the  
3 Gulf of Mexico and looking back at the southeastern portion of  
4 the country, that portion of the movie?

5 A. That's correct.

6 Q. And you're telling us that there was a vertical scale  
7 associated with that?

8 A. There's generally in this -- you can't see it on the  
9 straight down view, but on angled views there's what they call  
10 the bounding box which shows the extent of the vertical  
11 domain.

12 Q. I sit corrected, Mr. Wheeler.

13 A. If you look at those, the top of the modeling domain is  
14 about 15 kilometers.

15 Q. About 15 kilometers?

16 A. That's correct.

17 Q. To the top of the brown cloud, would that be correct?

18 A. To the what?

19 Q. Top of the brown cloud.

20 A. No. Most of this process, if we looked at them, would be  
21 in the range of, I'd say, 2 to 3 kilometers above the ground.  
22 At the time we're at 15 kilometers, we're in the stratosphere.

23 Q. All right, sir. And I apologize for asking this,  
24 Mr. Wheeler. I suspect you've already testified to this, but  
25 I frankly missed it in my notes. This was showing, if I'm

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1 correct -- well, if I'm incorrect, let me know. But I believe  
2 that this was showing the transformation of sulfur dioxide  
3 into sulfate with Dr. Staudt's TVA base case for 2013; is that  
4 correct?

5 A. That is correct.

6 Q. And again, as we've already established, this sweeps in a  
7 number of sources other than TVA plants.

8 A. Yes.

9 Q. Mr. Wheeler, you were provided with information  
10 concerning the -- let me back up and start over again. Let's  
11 look very -- just briefly again, if you would, please, sir, at  
12 Plaintiff's Exhibit 138 you used for your geographic tour of  
13 North Carolina.

14 A. 138. Yes.

15 Q. And this is information that, as I believe you corrected  
16 me and I appreciate the correction, that you obtained from the  
17 2005 Clean Air Act -- Clean Smokestacks Act report.

18 A. Yes.

19 Q. Did you or Mr. Chinkin or your colleagues at STI do any  
20 modeling for the impacts from emissions from North Carolina's  
21 own power plants?

22 A. No. As I mentioned, our charge was to evaluate the  
23 impacts of TVA sources on North Carolina and the region, as  
24 well as look at the potential benefits of additional controls.

25 Q. And I believe you mentioned just a few moments ago that

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1 the modeling you did on TVA was over the entire TVA fleet.

2 A. You're talking about the movie?

3 Q. Well, let me back up and be clear. I apologize for that.

4 I'm being a little obscure and I'm sorry for that.

5 What I want to do is in terms of the modeling you did for  
6 TVA's impacts in terms of PM<sub>2.5</sub>, both the 24-hour and the  
7 annual, the 8-hour ozone, and the -- I believe the sulfate and  
8 nitrate deposition, as well as the impacts from visibility,  
9 you looked at the TVA system as a whole, correct?

10 A. Each facility was modeled separately. The controls that  
11 were developed by Dr. Staudt were based on a system wide cap.  
12 TVA's system as a whole.

13 Q. So you did model each TVA plant separately.

14 A. Yes, we did.

15 Q. But you did not report on those results, did you?

16 A. No. What I'm saying is we did not look at the impacts  
17 from each separately, but each facility was modeled separately  
18 within the domain. I guess that's semantics. We did not look  
19 at controls plant by plant.

20 Q. You didn't look at emissions impacts plant by plant  
21 either, did you?

22 A. No, we didn't.

23 Q. So you're not able to tell me what the air quality  
24 impacts would be from, for instance, TVA's plants in Kentucky,  
25 Shawnee and Paradise.

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1 A. I could probably do an analysis based on the emission  
2 levels from various plants and transport. But no, we did not  
3 do that as a part of this analysis.

4 Q. Nor did you do an analysis of the air quality impacts  
5 from TVA's plants just in Tennessee.

6 A. Just in Tennessee? As I just said, we treated these all  
7 as a system because we were modeling a system wide cap.

8 Q. And you'd give me the same answer for the TVA plants in  
9 northern Alabama.

10 A. Yes.

11 Q. And just so that we're complete on this line of  
12 questions, you can't give me the impacts from the individual  
13 TVA plants that are in the eastern part of the system in  
14 Tennessee: John Sevier, Bull Run and Kingston.

15 A. I cannot from this modeling.

16 Q. You could have done that modeling if you'd been asked to  
17 do it.

18 A. I could have. It was very time -- these modeling  
19 simulations are very computation expensive. Takes a lot of  
20 time, months, in fact, to do angle simulations. And to do  
21 plants for an entire year case by case, we'd probably be  
22 getting the results about now.

23 Q. Mr. Wheeler, dealing with my own modelers, I have some  
24 understanding of what you're saying.

25 I think you would agree with me, would you not, that the

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1 power plant further away from North Carolina is less likely to  
2 have an air quality impact on North Carolina; isn't that  
3 correct?

4 A. Yes, that is correct. Unless they were much larger than  
5 the ones closer to North Carolina.

6 Q. Mr. Wheeler, I believe you're familiar with North  
7 Carolina Department of Environment and Natural Resources and  
8 its air quality modeling capabilities.

9 A. Yes.

10 Q. Did you have -- did you make use of those capabilities in  
11 this case?

12 A. No, we did not, other than obtaining files for the VISTAS  
13 modeling from them.

14 Q. So as far as you know, sir, North Carolina's Department  
15 of Environment and Natural Resources did not do any modeling  
16 for STI in this case.

17 A. They did not. None to my knowledge, and that was --  
18 nothing was incorporated in any of our reports or analysis.

19 Q. And I believe this is probably implicit in answer to an  
20 earlier question. But STI did not do any modeling of North  
21 Carolina's power plants' impact on air quality in North  
22 Carolina or elsewhere.

23 A. As I mentioned before, that was not the objective of  
24 these analysis. It was to look at impacts from TVA facilities  
25 in the region and to look at the potential benefits of

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1 additional emission controls.

2 Q. So for instance, you did not model North Carolina power  
3 plants' impacts on any of the North Carolina noncompliance  
4 areas either for PM<sub>2.5</sub> or ozone.

5 A. No, I did not.

6 Q. Did you do any modeling -- did STI do any modeling of  
7 Blue Ridge Paper's impact on air quality in North Carolina?

8 A. No, I did not other than the fact that it's included in  
9 the inventory. So total concentrations in the region that we  
10 calculated would include emissions from that plant.

11 Q. Did you recommend to the North Carolina Department of  
12 Justice that STI do model the impacts on air quality from  
13 North Carolina's power plants?

14 A. No. It seemed inappropriate considering the action and  
15 what was trying to be achieved in it.

16 Q. Did you make any recommendation concerning modeling Blue  
17 Ridge Paper's impacts on air quality?

18 A. No, I did not. Again, that was not the objective of the  
19 study.

20 Q. Mr. Wheeler, would you please turn to Plaintiff's Exhibit  
21 146. This is the CMAQ predicted maximum percent improvement  
22 in 24-hour average PM<sub>2.5</sub> concentrations with additional  
23 controls on TVA's coal-fired power plants.

24 A. Yes.

25 Q. Do you have that in front of you, sir?

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- 1 A. I do.
- 2 Q. I want to make sure I understood what you told
- 3 Mr. Goodstein in your direct testimony. If I understood, this
- 4 shows for each grid cell the one day during the year that the
- 5 indicated percentage improvement occurred; is that correct?
- 6 A. The one or could be more days. But the maximum
- 7 improvement over the course of the year. Just a different way
- 8 of displaying data.
- 9 Q. So this could be reflective of -- this is not necessarily
- 10 the same day.
- 11 A. This is correct.
- 12 Q. So this could be a number of different days showing
- 13 maximum impact in that particular grid cell.
- 14 A. That's right. We try to do statistics that are --
- 15 accumulate over the course of the year and this is one way of
- 16 doing that.
- 17 Q. So you -- looking at this particular plot, there's no way
- 18 of telling about the frequency of that maximum impact during
- 19 the year?
- 20 A. I didn't quite follow that, excuse me.
- 21 Q. Let me back up and try again.
- 22 A. Thank you.
- 23 Q. Looking at this plot, Plaintiff's Exhibit 146.
- 24 A. Yes.
- 25 Q. Looking at that, you can not infer anything from that

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1 plot as to the frequency of the impact during the year.

2 A. That's correct, you cannot on the frequency. The  
3 frequency was in the data that we provided to Department of  
4 Justice in terms of daily values that that could be analyzed  
5 from and was used by -- in subsequent analysis by other  
6 experts.

7 Q. If I might ask, sir, which other experts?

8 A. The health effects and ecosystem experts. As I  
9 mentioned, these are data summaries. Not meant to be a total  
10 analysis because of the large volume of data that must be  
11 provided.

12 Q. I appreciate your noting that, Mr. Wheeler. That's  
13 helpful.

14 But following along the same line as I was pursuing a  
15 moment ago, looking at this plot, you cannot infer from it the  
16 extent of the area affected by a particular percentage  
17 improvement on any given day.

18 A. Not on any given day. What it does depict is that there  
19 are potential benefits over a large area over the course of a  
20 year.

21 Q. Let's talk about that just in this context, Mr. Wheeler.  
22 There's nothing in this plot that would indicate that the --  
23 that the percent improvement that's measured in this plot  
24 occurred on a day when the 24 hour PM<sub>2.5</sub> was high enough to be  
25 of concern.

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1 A. PM<sub>2.5</sub> and ozone, regardless of its concentration, is of  
2 concern. As research currently shows, while we have standards  
3 that EPA puts on for level of concern, that health effects,  
4 ecosystem effects accumulate at concentrations much below the  
5 standard.

6 Q. But you will agree with me that currently the  
7 Environmental Protection Agency's National Ambient Air Quality  
8 Standard for PM<sub>2.5</sub> has been set -- and I will quickly say I  
9 don't remember off the top of my head the 24-hour standard,  
10 but the annual standard is 15 micrograms per cubic meter. I  
11 believe the 24-hour standard is somewhat higher than that.

12 A. Yes, it's 35 micrograms. And only a few years ago it was  
13 65 micrograms.

14 Q. I understand that, sir. But there is no way to tell from  
15 this plot --

16 A. This is not a plot to show benefits for attainment. This  
17 is to understand what the maximum impacts might be on human  
18 health and ecosystems.

19 Q. Just so it's clear in the record, what this plot does not  
20 show is whether the maximum improvement in a particular grid  
21 cell fell on a day when that grid cell was at or near or above  
22 the 35 micrograms per cubic meter standard.

23 A. It does not show that. And as I've stated, they're still  
24 important because we do not -- we know that there is not a  
25 break line for health and ecosystem impacts.

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1 Q. Mr. Wheeler, I'd like to draw your attention, if I could,  
2 to Plaintiff's Exhibit 165.

3 A. Yes.

4 Q. We'll return to this exhibit, but let me just ask this  
5 question. I'm referring particularly to the legend that  
6 appears in red --

7 A. Yes, sir.

8 Q. -- in the exhibit. And I understand that might be a  
9 little difficult to read in the copy that's in the book.

10 A. I'm familiar with the caveat.

11 Q. All right. I'd like to first of all direct your  
12 attention to "TVA's TCS plan, which is unlikely to be  
13 implemented." Do you see that language in the red -- in the  
14 red legend?

15 A. Yes.

16 Q. And sir, I believe -- well, you may not have been in the  
17 courtroom, but you would agree with me, for instance, that at  
18 least TVA is going forward with scrubbers at Bull Run and the  
19 Kingston fossil plants?

20 A. Based on testimony, I believe they're going forward. At  
21 the time of this report, we wanted to make sure that by our  
22 reanalysis of Tesche and Mueller's analysis, that we didn't  
23 imply that we agreed with this. We discussed this with  
24 Dr. Staudt at the time. He indicated there was no indication  
25 that these needed to be implemented during this time frame.

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1           And the note about errors dealt with some errors that  
2   Alpine Geophysics made in preparing the emission inventories  
3   for their runs.

4   Q.   We'll address that in a moment, Mr. Wheeler. But just so  
5   that we're complete on this point. When we're talking about  
6   the unlikelihood of TVA implementing what is referred to here  
7   as the TCS plan, or TVA's clean air compliance plan, that we  
8   are in fact -- you will agree with me that TVA is proceeding  
9   with scrubbers at Bull Run and at Kingston, and that Dr.  
10   Staudt was mistaken as to the efficiency of the scrubber on  
11   Paradise unit 3, and that Dr. Staudt also did not give us  
12   credit for the ongoing fuel switch at the Johnsonville plant.

13   A.   As I said before, the purpose, as Dr. Staudt described  
14   that if he hadn't given credits for those in the cap, then  
15   there would have been additional -- I mean, there would have  
16   been changes in other of your facilities.

17   Q.   Bottom line is, isn't it, Mr. Wheeler, that that  
18   statement is no longer accurate?

19   A.   Well, I think it was accurate at the time. I think --  
20   I'm not certain of TVA's plan or what the legal requirements  
21   are for that. As I mentioned, when we run future base cases,  
22   the first simulation like we did involves only required  
23   controls, not from a particular plan or something that's on  
24   the way. So it represents the base for likely controls.

25   Q.   Mr. Wheeler, I confess to being puzzled. My

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1 understanding was, certainly from EPA modeling guidance, that  
2 one of the things a modeler is supposed to do when trying to  
3 predict what emissions will be in future years, to include in  
4 the inventory allowances for additional control equipment that  
5 is being planned by sources of air pollution.

6 A. As I mentioned before, that's usually the second -- the  
7 third phase of the model in looking at potential additional  
8 controls, regulations that have been maybe promulgated but not  
9 implemented. Those are the on-the-way controls. And you  
10 may -- if you looked through the VISTAS reports, they model  
11 both on-the-books and on-the-way controls.

12 Q. And so you just modeled what you referred to as  
13 on-the-books controls.

14 A. Yes.

15 Q. And did not model the on-the-way controls.

16 A. That's correct.

17 Q. All right, sir. Now, returning to the comment you just  
18 made in terms of the errors that were made by Alpine  
19 Geophysics in terms of the emissions inventory from the TVA  
20 plants. You will agree with me, would you not, we're talking  
21 about two of the three units at TVA's Allen fossil plant and  
22 one of the units at TVA's Shawnee fossil plant.

23 A. I can't remember the exact plants, but that's -- I  
24 remember the facilities at Allen. There was some  
25 inconsistencies, I believe, in one other plant.

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## NEIL WHEELER - CROSS

1 Q. And if I represent to you that that was at the Shawnee  
2 plant, you have no reason to disagree with that.

3 A. I'd have to look at the tables for that. I think  
4 Mr. Chinkin will discuss that in his testimony.

5 Q. But you will also agree with me, and you can refer to the  
6 map that's up on the easel, that the Allen plant is located  
7 outside of Memphis, Tennessee; is that correct?

8 A. Yes.

9 Q. About as far west as you can get in the TVA system.

10 A. Yes.

11 Q. And that the Shawnee plant is also located in  
12 southwestern Kentucky; is that correct?

13 A. Yes, that's correct.

14 Q. And would you also agree with me that the unit at Shawnee  
15 that was left out of the inventory was unit 10 which is the  
16 atmosphere -- atmospheric fluidized bed combustion unit?

17 A. I can't verify that with my knowledge at hand.

18 Q. And you would agree with me that taking into account --  
19 or evaluating the error in the -- the omission of these three  
20 units, the two at Allen and the one at Shawnee, would produce  
21 less than .01 micrograms per cubic meter of PM<sub>2.5</sub> over North  
22 Carolina.

23 A. Was that reported in Dr. Tesche and Mr. Mueller's report?

24 Q. That was reported in Dr. Tesche and Mr. Mueller's  
25 supplemental report.

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1 A. Right. I don't remember the number.

2 Q. All right, sir.

3 MR. FINE: Pardon the lull, Your Honor. I'm just  
4 trying to keep myself organized. My pardon to the witness as  
5 well. I know it's been a long day for him as well as the rest  
6 of us.

7 Q. Mr. Wheeler, do you still have Plaintiff's Exhibit 165 in  
8 front of you?

9 A. Let's see. 165, yes.

10 Q. Thank you, sir. I believe that looking at the right-hand  
11 side of Plaintiff's Exhibit 165, and correct me if I'm wrong,  
12 I believe you described this as your replotting of Dr. Tesche  
13 and Mr. Mueller's plot that's represented on the left side of  
14 this page.

15 A. That is.

16 Q. And this is using -- and I believe you -- and help me  
17 with your terms, Mr. Wheeler, so I get it right. That you  
18 used a finely-resolved non-linear scale to represent those  
19 results.

20 A. Yes.

21 Q. And I believe that you testified in response to a  
22 question from counsel for North Carolina that the use of these  
23 finely -- finely-resolved non-linear scales was appropriate in  
24 air quality modeling.

25 A. These are used and have been for decades in air quality

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1 analysis. As a modeler, I'm somewhat embarrassed that  
2 modelers, particularly when they have to generate a lot of  
3 plots, using the tool that we typically use with CMAQ, a  
4 program called PAVE defaults to a linear plot and it takes  
5 some effort to construct the non-linear plots and thus they're  
6 not used a lot.

7 Q. And of course, we've heard a great deal of discussion  
8 about the Environmental Protection Agency's Clean Air  
9 Interstate Rule and its vacation by the D.C. Circuit Court of  
10 Appeals last Friday. I think you're also aware that the EPA's  
11 Clean Air Mercury Rule was also vacated by the court.

12 A. Yes, sir.

13 Q. Putting those results to one side, however, when EPA  
14 promulgated those two rules, the Clean Air Mercury Rule and  
15 the Clean Air Interstate Rule, part of the documentation when  
16 they issued those rules was fairly extensive modeling.

17 A. Yes, I'm familiar with that.

18 Q. And I'd be correct in saying that the -- that the tile  
19 plots they produced in that modeling used linear and not  
20 non-linear scales.

21 A. There's many different ways to do that. As I said, not  
22 everyone is trying to analyze to show all of the data.

23 Q. If you would answer my question, Mr. Wheeler. EPA used  
24 linear scales.

25 A. I believe they did. I don't have the document in front

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## NEIL WHEELER - CROSS

1 of me, but...

2 Q. And if we can just look at the level of concentration  
3 that we're talking about that are represented in the  
4 right-hand portion of Plaintiff's Exhibit 165. What is the  
5 lowest concentration that you're representing in your  
6 finely-resolved non-linear scale?

7 A. It's one one-hundredth of a part per billion -- or this  
8 is a microgram per cubic meter, excuse me.

9 Q. One one-hundredth of a -- of a microgram per meter -- per  
10 cubic meter.

11 A. Yes.

12 Q. And I would be correct in saying in terms of measuring  
13 particulate matter in a field monitor, that the finest  
14 resolution that you can get in the field monitor is  
15 .5 micrograms per meter -- cubic meter.

16 A. I believe they're often reported to a tenth. However, as  
17 I pointed out, there's a difference between measurements and  
18 modeling.

19 Q. But you would agree with me at some point there has to be  
20 a connection between modeling and the real world, correct?

21 A. Yes.

22 Q. And you would agree with me that the concentrations that  
23 you are displaying with your finely-resolved non-linear scales  
24 are not measurable by several orders of magnitude by any field  
25 monitor currently in existence?

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## NEIL WHEELER - CROSS

1 A. I should point out these are not predictions of  
2 concentrations. These are the changes in concentrations  
3 resulting from an emission control scenario.

4 Q. But would you agree with me that these changes in  
5 concentration are several orders of magnitude smaller than  
6 would be registered on any known or current field monitor?

7 A. Yes. And as I mentioned during my testimony, that I  
8 performed a number of analyses to understand whether these are  
9 reasonable levels to present differences in concentration  
10 resulting from these control modeling scenarios. In fact,  
11 these are the same levels that many organizations have  
12 reported differences to both for ozone and PM<sub>2.5</sub>.

13 Q. Would I be correct in stating that your displaying these  
14 concentrations out to these levels in the one hundredth of a  
15 microgram per cubic meter is displaying a high level of faith  
16 in the accuracy of the CMAQ model predictions for 2013 PM<sub>2.5</sub>?

17 A. I believe these are a level of the accuracy for  
18 predicting differences in concentrations resulting from  
19 control scenarios.

20 Q. But you would agree with me that you're attempting --  
21 that this is displaying a tremendous level of confidence, of  
22 faith, in fact, in your modeling results.

23 A. This is an indication of my faith in the modeling  
24 results.

25 Q. If I could ask you to turn to Plaintiff's Exhibit 160.

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## NEIL WHEELER - CROSS

- 1 A. Was that 150?
- 2 Q. I'm sorry, 160.
- 3 A. 160.
- 4 Yes.
- 5 Q. I believe, sir, that I've got the correct exhibit in
- 6 front of me. This is the visibility improvements with
- 7 additional controls on TVA's coal-fired power plants.
- 8 A. Yes.
- 9 Q. And just so that we're clear, and I believe you already
- 10 testified to this, this lists the days with the largest
- 11 improvements to visibility.
- 12 A. That is correct.
- 13 Q. And it does not display the frequencies of the predicted
- 14 visibility improvements.
- 15 A. We do in the additional tables, we show the frequency of
- 16 perceivable visibility improvement.
- 17 Q. But this particular exhibit, Plaintiff's Exhibit 160,
- 18 does not display any frequencies.
- 19 A. No, this does not.
- 20 Q. All this displays is a particular day where you had
- 21 the -- where you modeled the maximum visibility impact.
- 22 A. That's correct.
- 23 Q. And isn't it true that under the Environmental Protection
- 24 Agency's Regional Haze Rule, that the EPA rejected looking at
- 25 just single days of maximum impact?

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## NEIL WHEELER - CROSS

1 A. This is not a Regional Haze Rule analysis. This is a  
2 data display to indicate the maximum values that could be --  
3 that were achieved in the modeling results.

4 Q. I apologize, sir, if my question wasn't clear, but I  
5 asked you whether the Environmental Protection Agency in its  
6 Regional Haze Rule rejected the use of single days of maximum  
7 impact --

8 A. Yes, they did.

9 Q. -- in favor -- they did. Thank you.

10 And doesn't this visibility analysis portrayed in  
11 Plaintiff's Exhibit 160, doesn't it also fail to take into  
12 account natural phenomenon that could affect visibility, such  
13 as fog or rain or snow?

14 A. Visibility can be affected by those. To the extent that  
15 those are modeled, humidity, precipitation are covered in the  
16 modeling system. I think Mr. Molenaar, our expert on  
17 visibility, will be the more appropriate person to have a  
18 discussion with.

19 Q. You understand, sir, that I'm trying to pursue questions  
20 on evidence that you have presented here today.

21 A. Yes.

22 Q. Mr. Wheeler, the attorney for North Carolina asked you, I  
23 think, fairly early in your testimony, to identify for the  
24 record the reports that you and Mr. Chinkin with the  
25 assistance of your colleagues at STI prepared for this case.

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## NEIL WHEELER - CROSS

1 A. Yes.

2 Q. And one of those reports that you identified was what's  
3 labeled in your binder as a letter report?

4 A. That's correct.

5 Q. And I understand that it's only been identified by you at  
6 this point, but it has been marked for identification as  
7 Plaintiff's Exhibit 466. I think at the very back of your  
8 binder.

9 A. Yes.

10 Q. I believe, Mr. Wheeler, that -- and I'm looking now at  
11 page 4 of this document that's been marked for identification  
12 as Plaintiff's Exhibit 466. Are you with me there, sir?

13 A. Yes, I am.

14 Q. And there's a heading that says Southern Appalachian  
15 Mountain Initiative Modeling?

16 A. Yes.

17 Q. And that's what we've been referring to in this trial as  
18 SAMI.

19 A. That's correct.

20 Q. Sir, you are familiar with the modeling used for SAMI,  
21 are you not?

22 A. I am.

23 Q. And just so -- just some basics before we get into more  
24 specific matters. The SAMI modeling was conducted, oh, back  
25 in a time period prior to 2002.

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## NEIL WHEELER - CROSS

1 A. Yes.

2 Q. In fact, using an inventory that I think was built off of  
3 1990 inventory data.

4 A. I believe it was 1990, yes.

5 Q. And you would agree with me, would you not -- in fact,  
6 you testified to this in your direct testimony, that since the  
7 SAMI modeling was performed, we've had major increases in  
8 computing power.

9 A. Yes.

10 Q. That it's had a dramatic impact on how we perceive -- how  
11 we can use computer-based atmospheric modeling.

12 A. Yes.

13 Q. And if I'm correct -- and if I'm not, please tell me so.  
14 The SAMI modeling used a model that had the acronym URM-1ATM.

15 A. Yes. URM-1 Atmosphere Model. It's a derivative of the  
16 photochemical model developed by the California Institute of  
17 Technology.

18 Q. And you would agree with me that as worthy a model as  
19 URM-1 Atmosphere may have been at one point in time, it's no  
20 longer the state-of-the-science atmospheric modeling system.

21 A. I believe SAMI is not current as state of the science as  
22 the CMAQ and CAMX, yes.

23 Q. And you'd also agree with me that the SAMI inventory,  
24 both in terms of the emissions that were included in that  
25 inventory and the methodology used in assembling that

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1 inventory is now dated.

2 A. I think we might call it dated, although I have been able  
3 to glean important information out of older inventories and  
4 older modeling systems. They give us considerable information  
5 about impacts. It may not be as accurate and precise as the  
6 current modeling systems; but when analyzed properly, it  
7 provides important information about impacts.

8 Q. But you would agree with me, would you not, that the SAMI  
9 inventory is not comparable in accuracy and reliability with  
10 the VISTAS inventory.

11 A. I'd agree with that. Each generation provides better  
12 inventories.

13 Q. And so using the VISTAS inventory as opposed to the SAMI  
14 inventory would produce more accurate and reliable results.

15 A. Yes. But as I said, there's still much to be gleaned  
16 from earlier monitoring studies. They tend to corroborate  
17 more recent studies and put the impacts in a historical  
18 perspective.

19 Q. But again, SAMI, both in terms of its modeling, the  
20 contents of its inventory and the methodology in assembling  
21 that inventory is what I have termed dated.

22 A. It is old.

23 Q. And in fact, the URM-1 Atmosphere Model is now used  
24 merely as a training tool for people beginning to study how to  
25 be atmospheric modelers.

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- 1 A. I wasn't aware of that.
- 2 Q. And the SAMI modeling -- again, this is -- I believe this  
3 is a reflection of the computing power that was available at  
4 the time. The SAMI modeling modeled some nine episodes of  
5 between three and seven days in length.
- 6 A. Yes. I don't remember the exact lengths, but it was a  
7 composite of episodic modeling.
- 8 Q. As opposed to the ozone season, full ozone season or, for  
9 that matter, full year modeling that is now routinely done  
10 with CMAQ and CAMX.
- 11 A. Yes, that's most of the state of the science now.
- 12 Q. The state of the science has moved on.
- 13 A. It has. But as I keep reminding you is that there are  
14 useful results out of these older modeling applications.
- 15 Q. Mr. Wheeler, it's -- I would be correct in stating that  
16 you, in fact, did a review or participated in a review of the  
17 SAMI Air Quality Modeling Draft Final Report.
- 18 A. That's correct.
- 19 Q. And in fact, wrote -- or cosigned a letter with comments  
20 to the SAMI technical coordinator Pat Brewer in April of 2002  
21 conveying your comments on the SAMI model.
- 22 A. Yes.
- 23 Q. And would you -- do you recall what your -- the general  
24 tenor of your comments were?
- 25 A. Our general tenor was there wasn't enough information

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1 provided to accurately assess the modeling.

2 Q. You would agree with me, would you not, that you said,  
3 "While the available measurement data are probably adequate to  
4 evaluate the model's performance for ozone, the IMPROVE  
5 aerosol and the NAPAP wet deposition observations are too  
6 limited to support a credible evaluation of these model  
7 estimates. The integrated assessment of changes in visibility  
8 in forest effects from emission changes in the SAMI region is  
9 seriously undermined by the sparse spatial and temporal  
10 coverage of the aerosol and deposition data."

11 A. I can't remember those exact words, but that may be the  
12 tenor.

13 Q. I can show them to you if that would refresh your  
14 recollection.

15 A. No, that seems the sort of information we would have  
16 said. This was a joint review by me and Fred Lurmann of STI.

17 Q. And you went on to say, "The authors generally made  
18 reasonable choices for modeling systems and model components  
19 although some components were not the latest science when they  
20 were selected in 1998. For example, more scientifically  
21 up-to-date versions of the SAPRC gas-phase chemical mechanism  
22 and the secondary organic aerosol yield and partitioning  
23 algorithm were available."

24 A. Yes.

25 Q. And as you said that "the sources of uncertainties are

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## NEIL WHEELER - CROSS

1 broadly identified in the report. The implications of  
2 uncertainties are poorly quantified. The discussion of  
3 uncertainties is cursory and lacks depth."

4 A. Yes.

5 Q. And then you said, "The authors also are not very  
6 critical of their modeling system and appear quite tolerant of  
7 poor model performance."

8 A. I believe that's true.

9 Q. You went on to say, "Yet, the model's performance is very  
10 disappointing for particulate matter, for PM, and deposition  
11 and undermines the scientific integrity of the work."

12 A. Yes.

13 Q. And again, based on your evaluation of the draft modeling  
14 report from SAMI, "In our opinion, the scope of the database  
15 for PM and the deposition is inadequate, and the actual  
16 performance of the model in simulating the limited data is  
17 inadequate to achieve the stated purpose with scientific  
18 integrity".

19 A. Yes.

20 Q. And again, sir, you said in evaluating the draft final  
21 report, "Documentation of the emissions data and data  
22 processing and of the diagnostic model testing and uncertainty  
23 analysis are nonexistent or not referenced."

24 A. I believe that's true. It did not provide that  
25 information to us.

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1 Q. And you went on to say, "We do not believe that the  
2 unavoidable uncertainties have been adequately identified.  
3 While a list of uncertainties is provided in the report, no  
4 attempt to quantify or otherwise evaluate these uncertainties  
5 was made. The lack of evaluation and discussion of the impact  
6 on these uncertainties in the actual simulations makes it  
7 difficult to assess their impact on the report's conclusions.  
8 However, this lack of information impacts the integrity of the  
9 study and its conclusions."

10 A. Yes.

11 THE COURT: Now, if you want to read any more of  
12 that, I want you to read it all at one time so we can speed  
13 this up a little, Mr. Fine.

14 MR. FINE: I beg your pardon, Your Honor. I'll  
15 proceed in that manner.

16 THE COURT: Yes. Read all of that that you want him  
17 to respond to.

18 MR. FINE: All right sir.

19 Q. "Further, we believe that several of the uncertainties  
20 described may have been avoidable. For example, the mismatch  
21 between measured and predicted species could have been  
22 addressed in how the modeled species were defined. Also, it  
23 may have been possible to address the precipitation errors and  
24 their impact on wet deposition through the use of observed  
25 precipitation.

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1 "A deficiency of the study, as reported, is the lack of  
2 sensitivity analyses to investigate, understand and quantify  
3 uncertainties."

4 And further into the document, "If well designed  
5 performance goals had been established and met, the results of  
6 this modeling might have been used quantitatively. Given the  
7 modeling system's performance and the lack of additional  
8 information about model uncertainties, these results are best  
9 used qualitatively. As we have indicated in preceding  
10 comments, the model performance problems and lack of  
11 discussion or explanation of model response suggest that the  
12 results should not be used quantitatively for SAMI's overall  
13 assessments.

14 "Based on the model results presented, we have some  
15 confidence that the model's response is directionally correct  
16 on a gross basis. However, this does not mean the directional  
17 response is correct in all locations. Because of the lack of  
18 a detailed discussion of model performance issues and  
19 uncertainties, we cannot say with any confidence that the  
20 magnitude of the model's response to emissions reduction is  
21 correct.

22 "Meteorological inputs, along with emission inputs, are  
23 key drivers of an air quality model's performance and  
24 response. Our review of the meteorological modeling report  
25 raised several concerns. These include biases in wind speed,

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1 the lack of evaluations for cloud cover and mixing depth, and  
2 the lack of evaluation for model-ready inputs.

3 "The assumptions and approach to establishing initial and  
4 boundary conditions are generally reasonable given the data  
5 available. However, leaving hydrogen peroxide out of the  
6 boundary conditions may be a significant flaw since it is most  
7 produced in the clean air chemistry.

8 "We do not have much confidence in the  $\text{NH}_3$  dry or  $\text{NH}_4$  wet  
9 deposition results. The model significantly overestimates  $\text{NH}_4$   
10 deposition.

11 "The Direct Decoupled Method has been applied to evaluate  
12 the air quality responses to changing emissions in each of the  
13 SAMI states and in other regions of the SAMI modeling domain.  
14 Please comment on your confidence in the DDM results.

15 "As we recall, one of the original objectives of the SAMI  
16 modeling was to develop 'response surfaces' to aid in control  
17 strategy design. It appears that the modeling team has used  
18 the DDM to meet this objective. However, the DDM can, at  
19 best, provide model sensitivity to small perturbations of the  
20 base-case conditions (not large changes). Furthermore, we  
21 have some difficulty evaluating the methods robustness  
22 considering the subjective nature of its comparison with the  
23 'brute force' method. Given the caveats presented, it is  
24 difficult to see the utility of this method in designing  
25 control strategies that often include emission reductions of

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1 50% or more in the future.

2 "While the report discusses uncertainties, it is lacking  
3 any discussion of uncertainty analysis. Without the  
4 evaluation and quantification of uncertainties, it is  
5 difficult to assess the utility of the study to support  
6 decision-making.

7 "It is regrettable that there were insufficient efforts  
8 to carry out the process outlined above for either the  
9 meteorological or air quality modeling."

10 I'm almost coming to the end.

11 "Frankly, using only 7 layers to characterize a 13  
12 kilometer troposphere is not state-of-the-science for regional  
13 modeling.

14 "Based on measurement and model sensitivity studies, it  
15 is inappropriate to use zero boundary concentrations for  
16 hydrogen peroxide.

17 "The general tendency for the model to underpredict high  
18 values and overpredict low values is not adequately discussed  
19 or interpreted.

20 "The use of the 10 percent emission reduction sensitivity  
21 provides some information about pollutant response locally.  
22 It is not clear whether these results have utility in  
23 designing control strategies of the magnitude being  
24 investigated by SAMI."

25 Do you recall making those comments?

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1 A. I don't recall every comment, but the general text is  
2 consistent with our evaluation that the model did not -- did  
3 not have enough information to assess its ability to model  
4 qualitatively -- I mean, quantitatively. That there is some  
5 use in the model in terms of qualitative assessment of air  
6 quality impacts.

7 Q. All right, sir.

8 MR. FINE: Your Honor, I have a few more specific  
9 questions and I would like to be able to hopefully conclude my  
10 cross today if that were possible.

11 THE COURT: Go right ahead. We're going to finish  
12 this witness before we quit.

13 MR. FINE: Very well, Your Honor. I'll bear that in  
14 mind.

15 THE COURT: All right, sir. I'll ask cross examiner  
16 to do likewise.

17 MR. FINE: I'm sorry, Your Honor, I didn't quite get  
18 that.

19 THE COURT: I say I'll ask -- apparently my mic  
20 isn't working. I'll ask the gentleman who does the cross  
21 examination to do likewise.

22 MR. FINE: Very well, Your Honor.

23 THE COURT: Mr. Goodstein.

24 MR. FINE: A moment, if you please, Your Honor.

25 THE COURT: Yes, sir.

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## NEIL WHEELER - REDIRECT

1 (Co-counsel conferred.)

2 MR. FINE: Your Honor, in reviewing my notes and  
3 consulting with my colleagues, that concludes my cross  
4 examination.

5 MR. GOODSTEIN: Very brief redirect, Your Honor.

6 THE COURT: All right.

7 MR. GOODSTEIN: Can we put up Plaintiff's Exhibit 1,  
8 please, which has been admitted into evidence.

9 REDIRECT EXAMINATION

10 BY MR. GOODSTEIN:

11 Q. I have two quick questions for you on this, Mr. Wheeler.  
12 This is the SAMI final report issued in August of 2002. That  
13 should be on your monitor.

14 A. Yes.

15 Q. You're familiar with this report.

16 A. Yes.

17 MR. GOODSTEIN: And can we go to page 2 of that  
18 report.

19 THE WITNESS: I'm sorry?

20 Q. Are you familiar with the participants in the SAMI  
21 study --

22 A. Yes, I am.

23 Q. -- that are listed on page 2?

24 A. Yes.

25 MR. GOODSTEIN: Should be on your monitor, Your

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## NEIL WHEELER - REDIRECT

1 Honor.

2 THE COURT: Oh, okay.

3 A. Yes.

4 MR. GOODSTEIN: And can we see the whole page,  
5 please, on the monitor. Oh, I guess we are.

6 Q. So let's look at the governing bodies at the top.

7 A. Yes.

8 Q. So these are the governing bodies that signed on to the  
9 SAMI final report.

10 A. That's correct.

11 Q. Including the U.S. Environmental Protection Agency, U.S.  
12 Forest supervisor, and many of the commissioners and  
13 secretaries of the departments of environment in the various  
14 states in the SAMI region.

15 A. Yes, there was very high level participation in SAMI.

16 Q. And all these bodies signed on to the final SAMI report.

17 A. Yes, they did.

18 Q. And its conclusions.

19 And was TVA involved in this study?

20 A. Yes, they were.

21 MR. GOODSTEIN: Can we pull up the organizations,  
22 please, on the screen.

23 Q. And was Alpine Geophysics the...

24 A. I believe they had a role in it.

25 MR. GOODSTEIN: Okay. So let's look at the

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## NEIL WHEELER - REDIRECT

1 organizations real quick.

2 Q. And does Tennessee Valley Authority appear in the  
3 organizations that signed on to the final report of SAMI's  
4 study?

5 MR. GOODSTEIN: If we could highlight that so Neil  
6 can see -- sorry, Mr. Wheeler can see where it is.

7 Q. Do you see where it is, Mr. Wheeler?

8 A. Yes.

9 Q. Do you recall that they were one of the organizations  
10 that participated in this study?

11 A. Yes, I do.

12 MR. GOODSTEIN: And can we go to Page 3 of that  
13 document also, please. And can we blow up the contractors  
14 that contributed to SAMI's research portion on Page 3.

15 Q. And do you see Tennessee Valley Authority listed in that?

16 A. Yes. They actually were a contractor to do -- perform  
17 the simulations.

18 Q. And do you see Alpine Geophysics --

19 A. Yes.

20 Q. -- Dr. Tesche's firm, also listed there?

21 A. Yes.

22 Q. So all of these contractors contributed to the SAMI  
23 effort and signed on to the final report.

24 A. Yes.

25 Q. And I am told that -- I am told that the VISTAS modeling

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## NEIL WHEELER - REDIRECT

1 has corroborated SAMI's conclusions with regard to SO<sub>2</sub>, sulfur  
2 dioxide, and visibility.

3 A. Yes, that's my understanding.

4 Q. That's your understanding as well.

5 A. Yes.

6 MR. GOODSTEIN: We have no further questions, Your  
7 Honor, of this witness.

8 THE COURT: Mr. Fine.

9 MR. FINE: Nothing further, Your Honor.

10 THE COURT: All right. That will conclude our work  
11 for today. And the witness is excused.

12 Thank you very much, Mr. Wheeler.

13 THE WITNESS: Thank you, Your Honor.

14 THE COURT: Take a recess until tomorrow morning at  
15 9 o'clock.

16 (Evening recess at at 5:58 p.m.)

17 UNITED STATES DISTRICT COURT

18 WESTERN DISTRICT OF NORTH CAROLINA

19 CERTIFICATE OF REPORTER

20 I certify that the foregoing transcript is a true  
21 and correct transcript from the record of proceedings in the  
22 above-entitled matter.

23 Dated this 16th day of July, 2008.

24 s/Cheryl A. Nuccio  
25 Cheryl A. Nuccio, RMR-CRR  
Official Court Reporter

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